May 2, 1911.

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POWER

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COCHRANE

Steam-Stack And Cut-Out Valve Heaters And Receivers Are Indispensable Where Surplus Exhaust Steam Is To Be Used For Heating The Building, For Drying Purposes, In Absorption Ice Machines, In Calendering Rolls, In Cooking Kettles, In Low-Pressure Steam Turbines, Etc.

The extra large separator attached to and forming a part of this heater has sufficient capacity to purify of oil *all* exhaust steam delivered by the engines and pumps, saving the cost of an independent oil separator and trap installed in a by-pass around the heater.

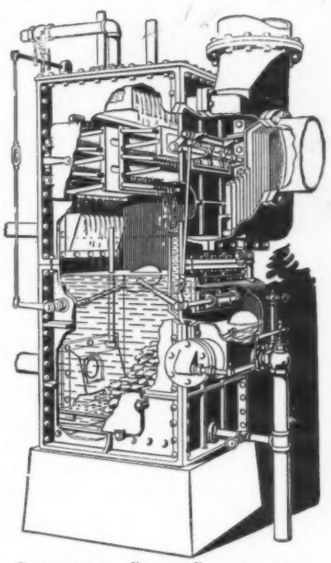
The separator and trap remain in service while the heater is cut out of circuit for cleaning or inspection, by means of the two valves incorporated in the construction and controlled from a single handle.

The fact that the valves are interconnected makes the apparatus fool-proof.

The engines cannot be stalled by wrong manipulation of the valves, as may happen with the ordinary by-pass arrangement.

Steam cannot be turned into the heater while it is open—the operator is therefore protected against scalding or other accident.

Steam discharged into the heater by high-pressure traps or from other sources cannot build up a dangerous pressure within the heater since the main steam valve between the separator and the heater is held to its seat by springs and will release.



COCHRANE STEAM-STACK AND CUT-OUT VALVE HEATER AND RECEIVER.

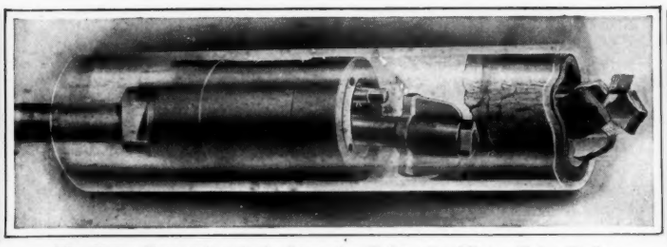
This is the "**FOOL-PROOF** Heater."

No other heater possesses all of these advantages.

If you have surplus exhaust steam which you wish to utilize for heating purposes, in low pressure steam turbines, in absorption ice machines, etc., ask for our "*Exhaust Steam Heating Encyclopedia.*" If you need more hot water for boiler feeding or other purposes, ask for the "*Profitable Utilization of Exhaust Steam.*" If you are troubled with scale in the boilers, ask for our booklet "*What Scale Does to Boilers.*" The protection of turbines and engines from water in the steam, and the purification of exhaust steam where a heater is not required, are discussed in our "*Talks on Steam and Oil Separators.*"

Harrison Safety Boiler Works

17th & Clearfield Streets **Philadelphia, Pa.**



The Dean Removing Scale from the Tube of a Water Tube Boiler.

The Dean Boiler Tube Cleaner for the small power plant

There's many a small power plant throwing away opportunities of saving money.

It's human nature to overlook small savings.

People would try to economize if they could make a big saving.

When the saving is small, they say: "What's the use?"

Take the subject of scale removal, for instance.

How many managers of small power plants take the cost of scale seriously?

"I have only two small boilers; more or less coal—what's the difference? What if the boilers are pushed?—I have enough steam to run the plant. Really, it wouldn't pay me to invest in a tube cleaner, no matter how meritorious it might be."

That's about the line of talk lots of men will give you.

But let's get down to brass tacks.

Can the Dean save money in a small power plant?

Yes, our records prove this conclusively.

We have lots of concerns on our books, operating two small boilers, saving two or three dollars a week on each boiler because they use a Dean to keep their tubes clean.

Not a large amount each week, to be sure—but what does it amount to in a year?

Don't you think that would be worth going after?

Remember this: We guarantee the Dean to pay for itself in six months' use; otherwise it may be returned at our expense and we'll refund the purchase price.

Doesn't that prove our belief in the Dean's ability to save money?

But before you even think of purchasing the Dean—try it out and find ont what it is and know what you're buying.

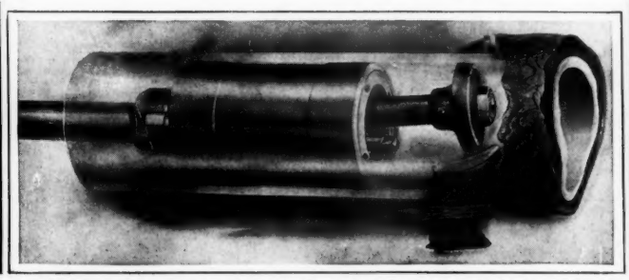
Shall we loan you a Dean for trial in one of your boilers?

Let us send you a copy of our interesting booklet, "Scale Removal Made Easy," anyway.

The Wm. B. Pierce Company

Jewett Building, Buffalo, N. Y.

Chicago Office: 801 Steinway Bldg.



The Dean Removing Scale from the Tube of a Return Tubular Boiler

POWER

NEW YORK, MAY 2, 1911

THE baseball season is now at hand and everybody is alive to the relative merits of the various teams.

Did you ever stop to consider what goes to make up a successful team? Is it individual playing or the earnest co-operation between all the members, each affording the other active support?

In answer to this question, it might be said that both are desirable, although the latter is the more important; in fact, it is absolutely essential to success. A collection of individual stars, each playing his own game without regard to the other or without any definite system, would be at the mercy of a well balanced team in which each member actively supported the others.

In short, the keynote to success is team work.

This holds true not only in athletics but in all business enterprises. To insure success all must work for the common cause.

Applied to the power plant it means that from the general manager down to the fireman all must strive toward producing better and more economical service.

Frequently, the men of one watch are detected in an attempt to let things slide over for the next watch, or if anything goes wrong they will sometimes attempt to shift the responsibility for it to the preceding watch. Such practice is sure to promote dissension and petty jealousies spring up which have no place in the operation of any plant.

Another important factor in economical operation is that of co-operation between the office and the operating force in the matter of purchasing supplies.

The motto, "A dollar saved is a dollar gained," does not always hold true in the power plant. The purchasing agent is apt to look to the price of an article without due regard to its adaptability; hence it may prove more expensive in the end.

On the other hand, if the purchasing agent, or general manager, and the engineer get their heads together and consider the subject from both points of view, that of price and that of durabliity and adaptability, they are very apt to effect a compromise which will prove satisfactory to all concerned and cheaper for the company.

Moreover, it will be found advantageous to acquaint the entire operating force with the cost of supplies.

If the oiler is appraised of the sum which the small daily waste in oil amounts to annually, he will take more pains to eliminate this waste. And if the fireman is impressed with the saving he can effect by more economical methods of firing, much will be saved in this respect.

Similarly, the engineer will be able to reduce the yearly packing bill.

It is the small losses that add up to an amazing figure at the end of the year. But by proper treament of employees, and system on the part of the management, reciprocated by team work on the part of the employees themselves, the losses can be cut down to a comparatively small figure.

Comparing Steam Turbine Tests

By A. G. Christie

When it is desired to compare the performances of two or more turbines operating under different conditions of pressure, superheat and vacuum, it is first necessary to reduce them to a common basis. This involves the determination of the "efficiency ratio" of each machine. By this is meant the ratio of the heat converted into useful work, per pound of steam, to the heat available through adiabatic expansion from the initial to the final pressures.

Anyone who has endeavored to compare the results of various steam-turbine tests understands the difficulty in making a fair comparison, especially when the tests have been performed under widely differing conditions. For instance, suppose turbine *A* has been tested at 200 pounds gage pressure, 150 degrees superheat and 28.9 inches vacuum, referred to a 30-inch barometer, and showed a steam consumption of 11.1 pounds per electrical horsepower-hour. Turbine *B* was tested under practically the same load with steam at 150 pounds gage pressure and 98 per cent. quality and with a vacuum of 27.8 inches and produced one electrical horsepower with 14.6 pounds of steam. A comparison of the steam consumptions per electrical horsepower-hour of these two turbines would require certain corrections to be made in the results of turbine *A* due to the steam pressure, superheat and vacuum being higher than in the case of turbine *B*. These corrections can be found only from the results of a long series of special tests under varying conditions of steam pressure, superheat and vacuum. Should such a series of tests be run on turbine *A*, the results might be misleading, for this turbine may have been designed to operate at its maximum efficiency under the conditions of the first test; hence, tests under other conditions would be in error to the extent of the variations in efficiency. As a rule, the results of such a series of tests are not at hand for every class of turbine and engineers have not agreed upon any standard corrections to be applied to any one class of turbine.

In the case of the test of turbine *B*, a correction must be made for the quality of the steam. The correction for dry steam would be as follows: The dry steam per electrical horsepower-hour equals

$$0.98 \times 14.6 = 14.308$$

It is generally agreed that turbines do not operate as efficiently with steam of 98 per cent. quality, as with steam at 100 per cent. quality, as the presence of moisture increases the friction and reheating effects, hence lowers the efficiency. For the purpose of illustration let it be supposed that turbine *B* is designed for maximum efficiency with dry steam at 150 pounds gage pressure and 28 inches vacuum, referred to a 30-inch barometer.

From the foregoing it is evident that the usual method of correcting the results of steam-consumption tests does not provide a satisfactory means of making comparisons which are fair to all turbines. On the other hand, there is a method of comparing the results of such tests which can be applied readily to any set of tests and is not liable to errors in the correction factors. This method involves the determination of the "efficiency ratio" of each machine; and, although not new in this country, it has not been used to the extent that it has in Europe.

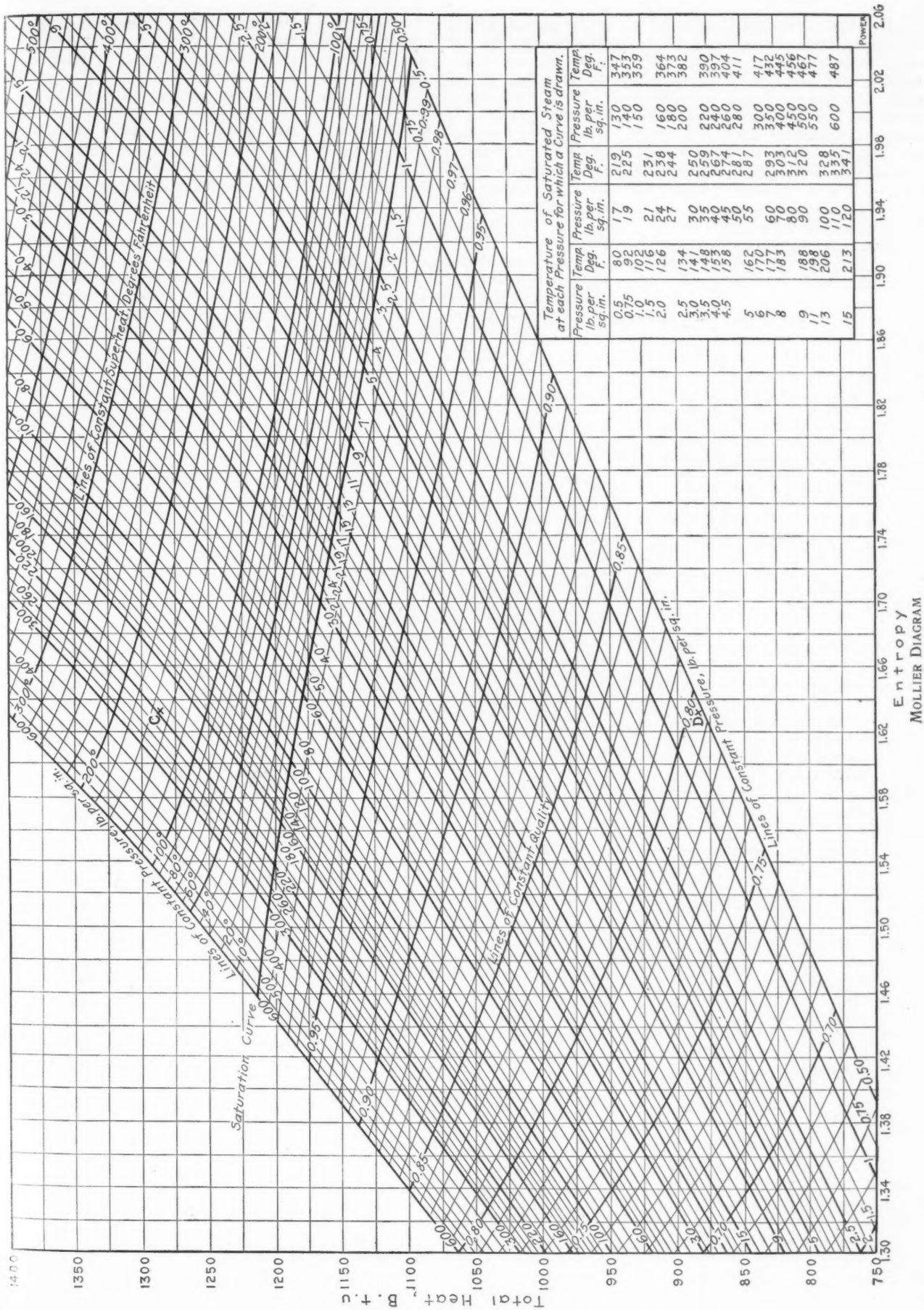
By "efficiency ratio" is meant the ratio of the heat converted into useful work, per pound of steam in the turbine, to the heat available through adiabatic expansion of the steam from its initial conditions of pressure, superheat and quality to its final pressure in the condenser. This may appear at first to be a complicated determination but, as will be shown later, it can be made very simple by the use of the heat charts which are now available.

A vapor is said to expand adiabatically when it neither receives heat from, nor gives up heat, except as work, to any outside body during expansion. All heat appearing as work must be supplied from the total heat in the vapor at the beginning of expansion. Hence, the heat, available as work, can be measured as the difference in the total heat in the steam at the beginning and at the end of expansion. In other words, with a given initial quantity of heat, the adiabatic expansion represents the maximum work that can be gotten out of a pound of steam in expanding from one condition to another. It represents the condition of maximum efficiency in all heat engines which depend for power upon the expansion of a vapor or gas, for there are present neither radiation nor internal losses. This forms a standard of efficiency with which actual results can be compared. The ideal turbine can be considered as working by adiabatic expansion of the steam and with neither radiation nor internal losses.

In the preceding discussion work has been referred to as a quantity of heat. Ordinarily, work is reckoned in foot-pounds of energy or in horsepower when the rate of its accomplishment is involved; but all these various units of work or power can be resolved into foot-pounds. It has been shown experimentally that 778 foot-pounds equal one B.t.u.; hence, work measured in foot-pounds, in horsepower or in other units can be readily transformed into equivalent B.t.u.

On a temperature-entropy diagram, an adiabatic expansion is represented by a line of constant entropy; for if the entropy increases during expansion, heat must have been added to the vapor or if the entropy decreases, heat must have been given up by the vapor. But, as adiabatic expansion is possible only when all the heat units given up during expansion are transformed into work, this condition occurs only when the entropy is kept constant. The term "isentropic" means equal or constant entropy and may be used instead of "adiabatic." There are several forms of entropy diagrams, the most convenient of which employ entropy and total heat per pound of steam as coördinates; of this type the Mollier diagram is the most widely known. This, which is here reproduced within the limits of the problem under discussion, contains curves of constant absolute pressure, constant quality and constant superheat. Such diagrams upon larger scales can be found in Stodola's *Steam Turbines*, Marks & Davis' *Steam Tables* and Thomas' *Steam Turbines;* Peabody's *Temperature-Entropy Tables* also give the values of such a diagram in tabular form.

To use the diagram for the determination of the heat available from adiabatic expansion, follow along the curve of constant absolute pressure to its intersection with the curve of constant quality or constant superheat, representing the initial conditions of the steam. The total heat in one pound of steam at that condition, can be read from the scale of coördinates at the left of the diagram. Note this amount of heat. Next, from this initial condition follow down the vertical ordinate of constant entropy until it intersects the curve representing the absolute terminal pressure of the expansion. Note the total heat at this condition. The difference in heat contents at the initial and the final conditions of the steam represents the heat available as external work per pound of steam due to the adiabatic expansion between the given limits. The absolute pressures are found in every case by adding the pressure corresponding to the barometer to the observed gage pressure.



Temperature of Saturated Steam at each Pressure for which a Curve is drawn.					
Pressure lb. per sq. in.	Temp. Deg. F.	Pressure lb. per sq. in.	Temp. Deg. F.	Pressure lb. per sq. in.	Temp. Deg. F.
0.5	80	17	219	130	347
0.75	92	19	225	140	353
1.0	102			150	359
1.5	116	21	231		
2.0	126	24	238	160	364
		27	244	180	373
2.5	134			200	382
3.0	141	30	250		
3.5	148	35	259	220	390
4.0	153	40	267	240	397
4.5	158	45	274	260	404
		50	281	280	411
5	162	55	287		
6	170			300	417
7	177	60	293	350	432
8	183	70	303	400	445
		80	312	450	456
9	188	90	320	500	467
11	198			550	477
13	206	100	328		
		110	335	600	487
15	213	120	341		

In a steam turbine, the expansion is not strictly adiabatic, owing to the internal losses and radiation. The radiation loss is usually small, but the internal losses are the real measure of the efficiency of a turbine and vary somewhat with different machines. These losses are often designated by such terms as blade friction, windage, eddying, etc., but all are manifestations of fluid friction. This may be due to the friction of the steam against the walls of the steam passages, to the friction between particles of the steam, or to leakage past the diaphragms and over the tips of the blades.

When friction losses occur in a vapor, a cycle of events occurs as follows: With steam flowing at a given velocity over a curved surface, such as a turbine blade, friction is set up between the steam and the blade and some of the energy due to the velocity of the steam is converted into heat. This heat increases the temperature of the metal surface. The next instant a cooler particle of steam comes in contact with this surface and absorbs this heat. Hence the heat loss due to this friction is returned to the steam itself, increasing the quality in the case of saturated steam and the temperature in the case of superheated steam. This increment of heat does not increase the capacity of the steam for doing work, as may be demonstrated by throttling steam from boiler pressure to atmospheric pressure. The volume at atmospheric pressure would then be many times greater than that at boiler pressure and the steam would probably be superheated. However, it would be useless to attempt to use this steam in a noncondensing turbine or engine for, although the heat in the steam may exceed that of dry steam at atmospheric pressure, no flow can occur until a drop of pressure is provided; therefore, no work can be done. Hence, internal friction of the steam in a turbine is a loss unless this steam is used for heating purposes. In most cases, this reheating of the steam in a turbine, through friction, has one beneficial effect in that it reduces the friction loss in later stages by supplying these stages with drier steam. It is well known that moisture in the steam materially increases the losses due to friction. The loss due to blade and diaphragm leakage is similar to that of throttling previously referred to.

When the heat available from adiabatic expansion has been determined, all that remains is to find the heat equivalent to work per pound of steam.

The results of the tests on any turbine will show the pounds of steam per electrical horsepower-hour or per brake horsepower-hour. If the turbines to be compared are both connected to electric generators, then it is necessary only to compare them on the basis of electrical horsepower, for as a rule, one contractor supplies both the turbine and the generator and makes his guarantee on the combined unit. If brake tests have been made on both units, comparison on a brake-horsepower basis is satisfactory. If one set of tests have been made with an electric generator furnishing the load and the other set with a brake load, then it will be necessary to reduce these to a common basis, in which case the efficiency of the electric generator must be known.

Assume that the tests have been made with electric generators as stated for turbines *A* and *B*. One horsepower equals 33,000 foot-pounds per minute, or

$$33{,}000 \times 60 = 1{,}980{,}000 \text{ } \textit{foot-pounds per hour}$$

Also, one B.t.u. equals 778 foot-pounds. It follows that

$$\textit{One horsepower} = \frac{1{,}980{,}000}{778} = 2545 \text{ } \textit{B.t.u. per hour}$$

Test results show for turbine *A* that 11.1 pounds of steam were required to produce one electrical horsepower of work which is equivalent to 2545 B.t.u. Hence, the heat per pound of steam actually converted into work equals

$$\frac{2545}{11.1} = 229.2 \text{ } \textit{B.t.u.}$$

From the Mollier diagram it will be found that there are 402 B.t.u. available per pound of steam due to adiabatic expansion from 214.7 pounds absolute and 537.8 degrees Fahrenheit to 0.54 pound absolute. This is found by first locating the point *C* at the intersection of the 214.7-pound pressure curve with the curve representing 150 degrees superheat; that is,

$$537.8 - 387.8 = 150 \text{ } \textit{degrees superheat,}$$

the 387.8 being the temperature of saturated steam at 214.7 pounds. Next, locate point *D* vertically below *C* and on the curve representing 0.54 pound. Referring to the scale on the left of the diagram, point *C* will be found to lie on the abscissa representing 1285 B.t.u. and *D* on the line representing 883 B.t.u.; therefore, the heat drop is

$$1285 - 883 = 402 \text{ } \textit{B.t.u.}$$

This shows an efficiency ratio of

$$\frac{100 \times 229.2}{402} = 57 \text{ } \textit{per cent.}$$

In the same way it can be shown for turbine *B* that the heat equivalent to work per pound of steam is 174.6 B.t.u. and the heat available from adiabatic expansion from 164.7 pounds absolute and 98 per cent. quality to 1.08 pounds absolute is 315 B.t.u.; hence, the efficiency ratio is

$$\frac{100 \times 174.6}{315} = 55.4 \text{ } \textit{per cent.}$$

Thus the efficiency ratio is a correct measure of the absolute efficiency of each turbine as it represents the ratio of the heat equivalent of useful work to the heat available, were the steam to expand freely with absolutely no losses in an ideal turbine.

Suppose, however, that one turbine has been tested with an electric generator and the other with a brake and it is desired to compare results on the basis of efficiency ratios. As stated before, the generator efficiency must be known. This can be obtained usually from the manufacturers and should include iron losses, copper losses, windage and friction. Assume that the tests of two 500-kilowatt turbines are to be compared. One is connected to an electric generator whose efficiency is 93 per cent. at full load; and in the test with a load of 670 electrical horsepower this unit required 9514 pounds of steam at 148 pounds gage pressure, 99 per cent. quality and 27.4 inches of vacuum, referred to a 30-inch barometer. The equivalent brake horsepower equals

$$\frac{670}{0.93} = 721 \text{ } \textit{b.h.p.}$$

and the steam consumption is 13.19 pounds per brake horsepower-hour.

The heat available through adiabatic expansion from 162.7 pounds absolute and 99 per cent. quality to 1.275 pounds absolute, is found from the chart to be 307 B.t.u. The heat utilized per pound of steam is

$$\frac{2545}{13.19} = 192.9 \text{ } \textit{B.t.u.}$$

and the efficiency ratio is

$$\frac{100 \times 192.9}{307} = 62.83 \text{ } \textit{per cent.}$$

The second turbine was tested with a brake. When running under steam at 155 pounds gage pressure and 98 per cent. quality, with a 28.5-inch vacuum, referred to a 30-inch barometer, the results showed a steam consumption of 13.05 pounds per brake horsepower-hour. The heat available from an adiabatic expansion from 169.7 pounds absolute and 98 per cent. quality to 0.737 pound absolute is found from the chart to be 330.5 B.t.u. The heat utilized per pound of steam was

$$\frac{2545}{13.05} = 195 \text{ } \textit{B.t.u.}$$

and the efficiency ratio is

$$\frac{100 \times 195}{330.5} = 59 \text{ } \textit{per cent.}$$

Hence, it would appear that the turbine tested with the generator is the more efficient unit.

By means of "efficiency ratios," a standard, varying only within the limits of the steam pressures used, can be determined; to this each turbine can be referred and an absolute efficiency ratio determined. A comparison of these efficiency ratios for several turbines will determine which is the most efficient regardless of the steam conditions under which they have been tested.

Friction Clutches and Their Use

By H. A. Jahnke

A continuation of the clutch descriptions appearing in the April 11 number, including clutches for gas and oil engines.

Dodge Clutches

Figs. 20, 21, 22 and 23 show the Dodge clutches. The Dodge clutches are of the disk type and are made in both split and solid patterns. The split clutch, Fig. 20, has one disk plate and is filled with hard-maple blocks the end-grain faces of which are pressed against the driving and clamping plates. The driving plate is keyed to the shaft while the outside clamping plate, by means of the levers shown, brings the wooden blocks in contact with the driving plate. When the clutch is in full, the wood-filled disk is

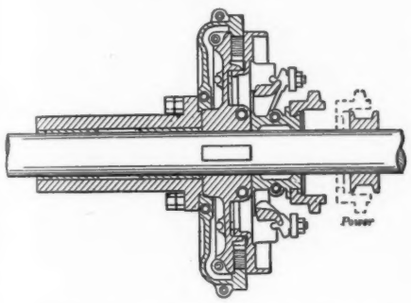


Fig. 20. Section of Dodge Friction-clutch Cutoff Coupling

securely clamped between the plates. The adjustments are made by tightening or loosening the locknuts on the draw bolts. A desirable feature of this clutch is its interchangeability. A pulley, sheave or gear used in connection with it may be of any size within the capacity of the clutch. Where much power is to be transmitted by the Dodge clutch, it is recommended that a sleeve be used which

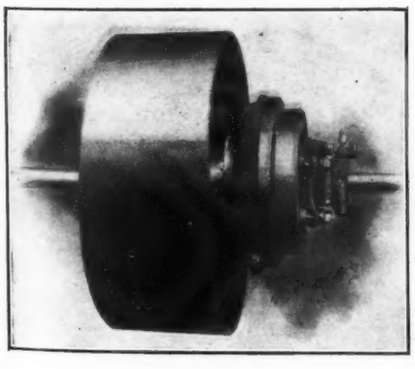


Fig. 21. Dodge Clutch with Steel Pulley

is long enough to permit the rise of two bearings, one on either side of the pulley. This will prevent all bending stress in the shaft due to the weight of the pulley.

These clutches are made by the Dodge Manufacturing Company, Mishawaka, Ind.

The Hunter Clutch

Fig. 24 shows the Hunter clutch, which may be used as a friction-clutch cutoff coupling, or in connection with a pulley. A novel feature of the Hunter clutch is that when not in use the friction hub can be withdrawn; thus, should the shaft get out of line there would be no contact between the friction surfaces, thereby avoiding all unnecessary wear.

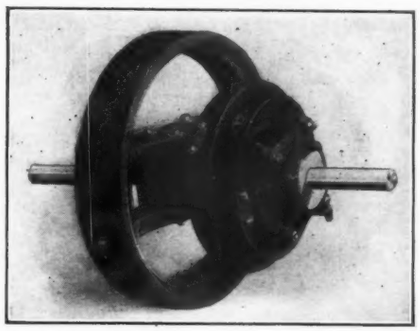


Fig. 22. Dodge Clutch with Wood Pulley

This clutch is made by the James Hunter Machine Company, North Adams, Mass.

The Medart Clutch

All of the operating mechanism of the Medart friction clutch, Figs. 25 and 26, is in full view, and self-locking. The clutch can be thrown in or out without shock or jar. All of the Medart clutches are furnished with stop bolts to limit the throw of the slide collar, making a set collar unnecessary. All clutch pulleys over 30 inches in diameter are fitted with V-shaped friction shoes as shown in Figs. 25 and 26.

The Medart Patent Pulley Company, St. Louis, Mo., manufactures this clutch.

The Lemley Clutch

Figs. 27 and 28 show the Lemley clutch. The Lemley clutch is provided with two or more sets of toggles, depending on the size of the clutch. The clutch has a universal adjustment which makes it necessary to move only one part to adjust all toggles. In this way equal pressure is secured on all friction surfaces.

The friction blocks are made of hard maple. These are riveted to the friction plate with copper rivets. The blocks are supported on both sides by flanges on the friction plate.

The Lemley clutch is made by the W. A. Jones Foundry and Machine Company, Chicago, Ill.

The Davis Clutch

Figs. 29 and 30 show the Davis clutch. This clutch is made with a friction ring

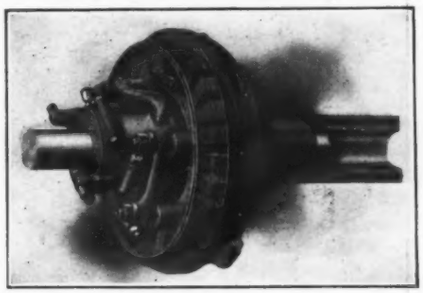


Fig. 23. Part Phantom View of Dodge Clutch, Showing Contact Blocks

or hub with a sleeve on which a pulley or gear can readily be mounted. On the body piece there are hinged two friction wings which extend all the way around the hub, and are operated by compound levers acting against set screws. The wings terminate in two sets of lips through which are passed steel bolts through springs; this arrangement assures plenty of clearance when the levers are dropped. The clutch is per-

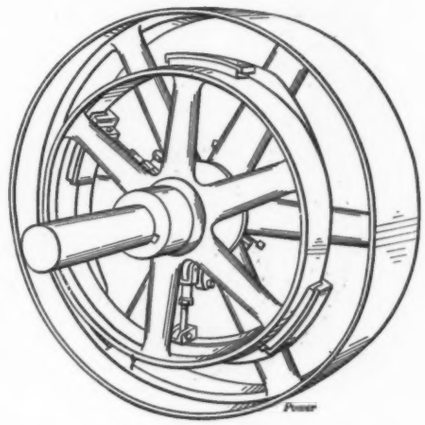


Fig. 24. The Hunter Clutch

fectly balanced and, therefore, vibration is practically absent.

The adjustment of this clutch is very simple and of almost unlimited range.

The Davis clutch is made by the Worcester Machine Company, Worcester, Mass.

The Reeves Clutch

The Reeves clutch is shown in Figs. 31 and 32. Extreme simplicity is one of the claims made for this clutch.

The metal friction wheel is clamped solidly to the shaft; the power is delivered by means of the wooden friction shoes,

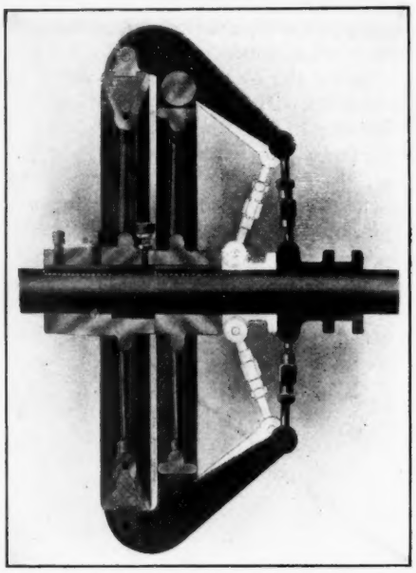


FIG. 25. SECTIONAL VIEW OF THE MEDART CLUTCH

which are connected to the belt wheel, and which, when the clutch is thrown in, bear upon the face of the friction wheel.

The pulley is fitted with a babbitted bushing and when the clutch is thrown out all of the working parts and the

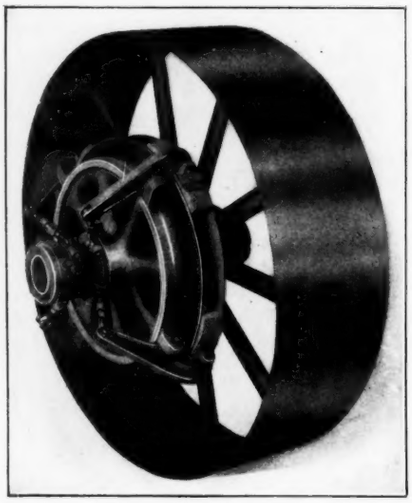


FIG. 26. MEDART CLUTCH ATTACHED TO PULLEY

pulley stand still. The friction shoes are operated by a toggle joint. The manufacturers of this clutch, the Reeves Pulley Company, Columbus, Ind., claim that, to the best of their knowledge, this is the only clutch which combines a wood split pulley with the clutch mechanism.

The Frisbie Clutch

The simple design of the Frisbie clutch is shown by the sectional view in Fig. 33. The pulley runs loose on the shaft; the

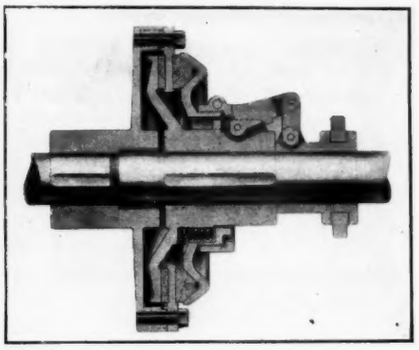


FIG. 27. SECTIONAL VIEW OF THE LEMLEY CLUTCH

hub of this pulley has a renewable bushing which takes all of the wear. The V-shaped friction ring is cast onto the arms of small pulleys and bolted onto those of the larger ones. The system of levers in the clutch spider, which is keyed solidly to the shaft, together with the friction shoes inside of the ring, forms the

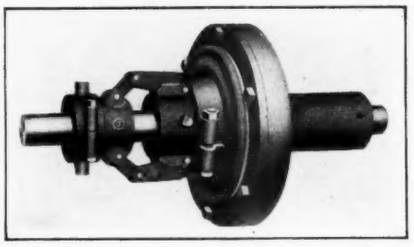


FIG. 28. EXTERIOR VIEW OF LEMLEY CLUTCH

operating mechanism. Movement of the sliding sleeve operates the latches which move the heavy dogs, and by means of the shoe bolts draws the four friction surfaces of the pulley and spider together in position and powerful contact.

The amount of pressure is regulated by the clamp nuts on the shoe bolts, which also take up lost motion caused by wear. The shoes and spider are fitted

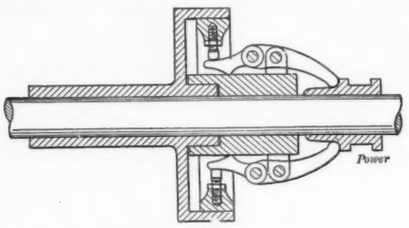


FIG. 29. SECTION OF DAVIS CLUTCH

with thoroughly seasoned maple contact blocks.

The Frisbie cutoff coupling is shown in section in Fig. 34. Both of these devices are made by the Eastern Machinery Company, New Haven, Conn.

The Warner Clutch

Fig. 35 shows the design of the Warner clutch. This clutch has two or more crucible spring-steel rings or bands which

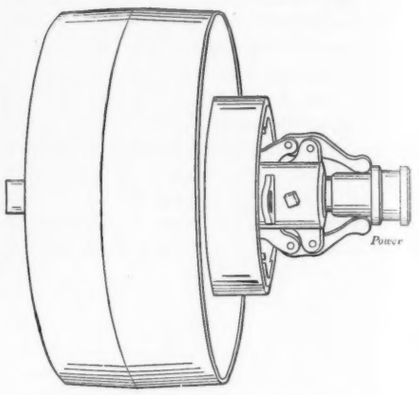


FIG. 30. DAVIS CLUTCH WITH PULLEY ATTACHED

are forced into frictional contact with the polished surface of a chilled-iron drum. The clutch mechanism is inclosed in a dust-proof case, and runs in an oil bath; the steel rings are practically unbreakable. The wear, which is very slight, occurs on the steel rings. The rings act one after another, thus insuring smooth engagement. When the clutch is used in connection with a pulley or gear it is fitted with a sleeve to which the pulley or gear can be keyed.

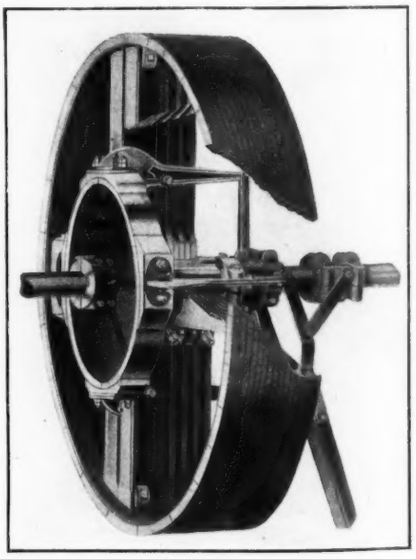


FIG. 31. PART SECTIONAL VIEW OF REEVES CLUTCH WITH PULLEY

When the clutch is used for a cutoff coupling, it is furnished with a hub, the driving shaft being keyed to the hub, while the driven shaft is keyed to the drum.

The Warner Clutch Company, Chicago, Ill., makes this clutch.

The Plamondon Clutch

A sectional view of the Plamondon clutch is given in Fig. 36. This clutch

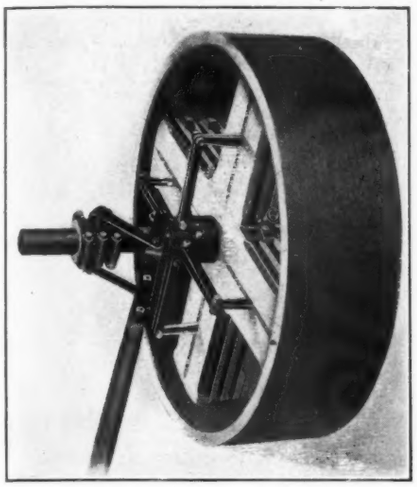


Fig. 32. Reeves Clutch and Pulley, Showing Mechanism

is powerful and simple, has few parts, contains no springs or bolts and is of such design as not to be affected by cen-

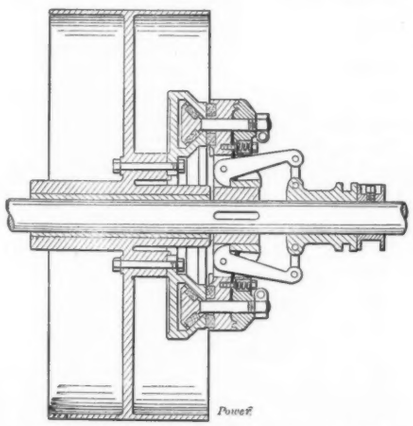


Fig. 33. Sectional View of Frisbie Clutch

trifugal action. Further, it is proof against dust and dirt, which fact makes it valuable for service in cement mills and the like.

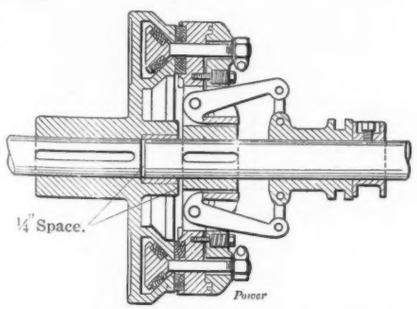


Fig. 34. Sectional View of Frisbie Cutoff Coupling

The friction plate *C* is lined on both sides with hard-maple segments, and is made in halves so that it can be removed for relining. In operation, the disks *A* and *B* are pressed against the plate *C* by means of the compound toggle arrangement *G*, *H* and *I*.

This clutch is made by the Plamondon Manufacturing Company, Chicago, Ill.

The Moore & White Clutch

Fig. 37 shows a sectional view of the Moore & White friction-clutch pulley, and

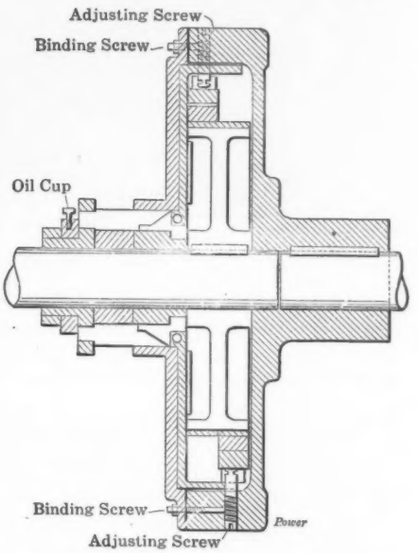


Fig. 35. Design of Warner Clutch

Fig. 38 shows the friction disk used in this clutch. The pulley is made with a long hub to give ample wearing surface. To the hub of the pulley is keyed a collar with lugs on one side which engage with lugs on the friction disk;

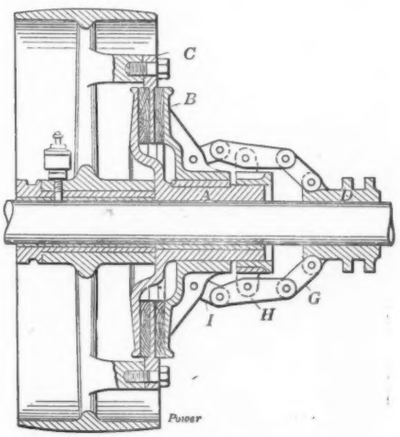


Fig. 36. Sectional View of the Plamondon Clutch

this causes the disk that fits loosely on the hub of the pulley to revolve with the pulley and at the same time leaves the disk free to vibrate sideways if necessary. The advantage of the disk being loosely connected to the pulley in this manner becomes manifest when the pulley wears loose on the shaft, or when the shaft, pulley or hub fails to run true. With this design wear of the friction surface is prevented when the clutch is disengaged.

The friction disk is filled with hard

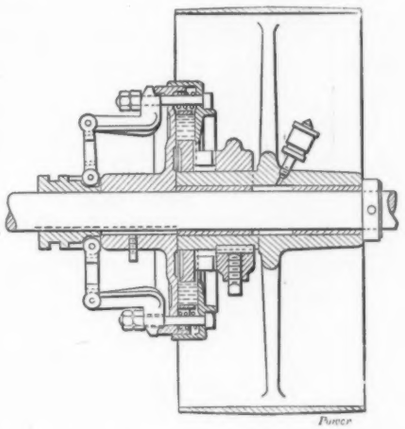


Fig. 37. Section of Moore & White Friction-clutch Pulley

wood and presents two end-grain wood surfaces for contact with the two iron surfaces. The iron surfaces are drawn into contact with the wood surfaces of the disk by a powerful mechanism. The

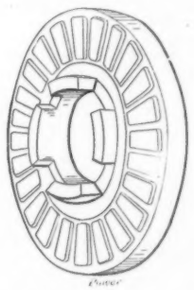


Fig. 38. Friction Disk of the Moore & White Clutch

clutch can be made in halves if necessary, and applied to wood pulleys, gearing and sprocket wheels. It can also be applied as a cutoff coupling for stopping

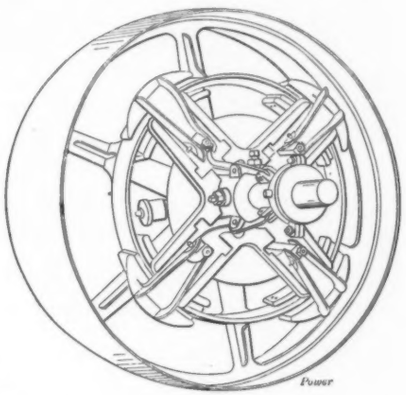


Fig. 39. The Falls Friction-clutch Pulley

and starting parts of line shafts. This clutch is manufactured by the Moore & White Company, Philadelphia, Penn.

The Falls Clutch

Figs. 39 and 40 show the Falls friction-clutch pulley, and Fig. 41 shows the

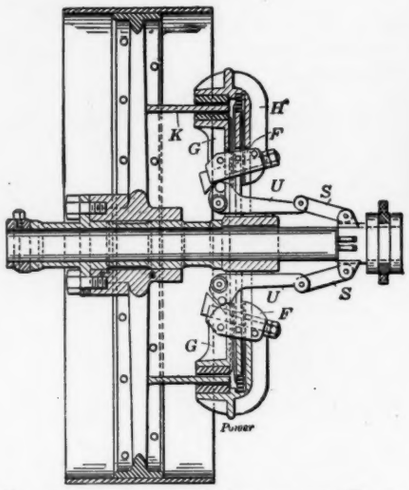


FIG. 40. SECTIONAL VIEW OF THE FALLS FRICTION-CLUTCH PULLEY

friction-clutch cutoff coupling. These clutches are made with four or six arms according to the amount of power to be

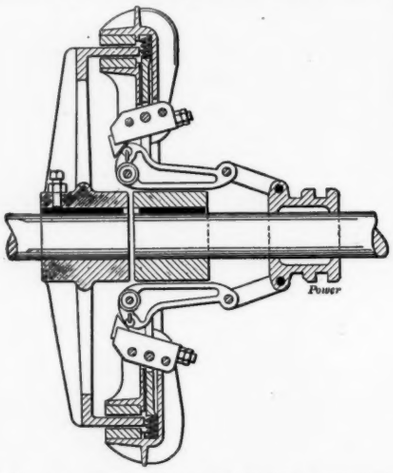


FIG. 41. THE FALLS CUTOFF COUPLING

transmitted. The pulleys are furnished with babbitted split sleeves for bearings; they are turned on the outside to fit the

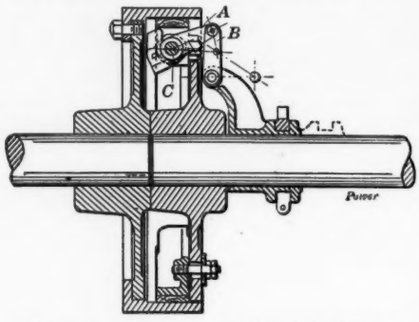


FIG. 44. SECTION OF A. & F. BROWN FRICTION-CLUTCH PULLEY

hub of the pulley and bored on the inside to fit the shaft. The sleeves are held in position by two cap screws.

The clutch ring *K*, Fig. 40, is generally made one-half the diameter of the pulley onto the arms of which it is cast.

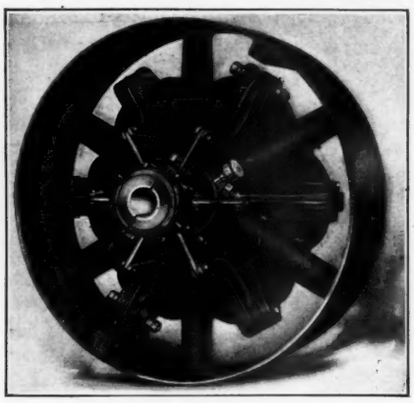


FIG. 42. ALLIS-CHALMERS FRICTION-CLUTCH PULLEY

The inner jaw *G* of the clutch arms is forced outward, and the outer jaw *H* inward, by means of the toggle levers *S*

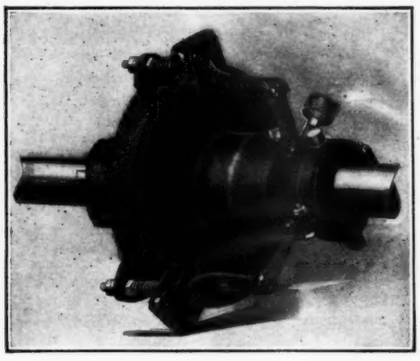


FIG. 43. ALLIS-CHALMERS FRICTION-CLUTCH COUPLING

and *U* which act upon the lever *F*. The clutch jaws are adjusted by means of the steel wedges in the lever *F*. Sea-

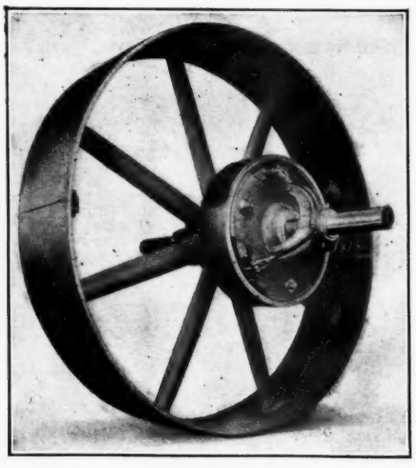


FIG. 45. A. & F. BROWN CLUTCH WITH PULLEY ATTACHED

soned maple is used for the clutch shoes.

The Falls Rivet and Machinery Company, Cuyahoga, O., makes the clutch.

The Allis-Chalmers Clutch

The Allis-Chalmers friction-clutch pulley is shown in Fig. 42 and the friction-clutch coupling in Fig. 43. These clutches are of the disk type. Although they are designed to be capable of carrying very

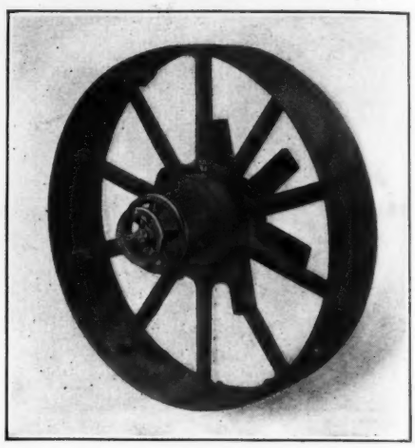


FIG. 46. THE SPRINGFIELD CLUTCH FOR GAS ENGINES

heavy load, they are made in sizes adapted for use in any place where power is employed.

The adjustment of two set nuts compensates for any wear of the friction surfaces. The cast-iron driving disk is clamped between two continuous wood surfaces. The clutches are made with either three or six arms, and, as the pressure is distributed uniformly over

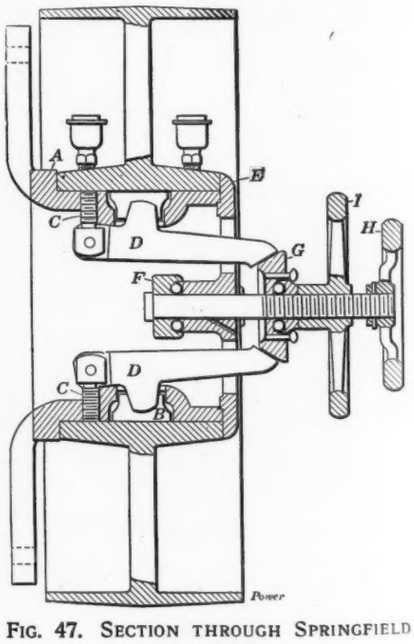


FIG. 47. SECTION THROUGH SPRINGFIELD CLUTCH

the entire friction surfaces, the clutches do not have to carry any one-sided strains. There are no springs in the mechanism. The pressure is regulated according to the load the clutch has to carry, by means of adjusting nuts on the eye bolts.

These clutches are made by the Allis-Chalmers Company, Milwaukee, Wis.

The A. & F. Brown Clutch

The A. & F. Brown clutch is shown in Figs. 44 and 45. This clutch is simple in construction and durable. The shifter collar, Fig. 44, operates the counterweighted lever *A* through the link *B*. The pin *C* carries a worm which, when the clutch is thrown in, forces the frame carrying the wood shoes against the friction hub. The object of the counterweight on the lever *A* is to prevent centrifugal force from influencing the action of clutch.

Fig. 45 shows a three-arm clutch with split pulley attached.

The A. & F. Brown Company, New York City, manufactures these clutches.

Clutches for Gas, Gasolene and Oil Engines

There are many points in favor of placing a friction clutch on gas and gasolene engines, especially where the load is heavy. One advantage is that the engine may be started slowly and gradually speeded up before any load is thrown on the engine. Another desirable point in having a friction clutch on the engine is that in case of an accident it is not necessary to stop the engine; the machines can be stopped or started by the friction clutch, thereby saving time and expense.

Springfield Clutch

Figs. 46 and 47 show the Springfield clutch pulley ready to be attached to the flywheel of a gas or gasolene engine. The pulley proper is mounted on a hollow bearing or spider *A*, Fig. 47, having arms which bolt to the flywheel. In the bearing is a recess or groove in which lies a friction ring *B* which is divided into two parts. Attached to the bearing by means of studs *C* are two levers *D* having wedge-shaped lugs extending between the ends of the friction ring. A face-plate *E* is bolted to the bearing or spider and provides a journal for the spindle. The inner end of the spindle is fitted with a ball-bearing thrust collar *F*. Mounted loosely on the spindle is a cone *G* which also forms part of the ball bearing.

To engage the clutch the handwheel *H* is held stationary and the wheel *I* is turned down on the spindle. This causes the cone *G* to force apart the ends of the arms *D* so that lugs enter the openings between the halves of the friction ring *B* and force it into contact with hub of the bearing.

The Springfild Gas Engine Company, Springfield, O., manufactures the clutch.

Lemley Gasolene-engine Clutch

Fig. 48 shows the Lemley gasolene-engine clutch pulley. The upper part of the figure shows the clutch designed to be bolted to the flywheel arms and the lower part shows the clutch as it is built to be keyed to the shaft.

The friction blocks are made of hard maple riveted to the clutch plate and make a continuous friction surface around the plate. To engage the clutch the handwheel is pulled out; to release, it is pushed in.

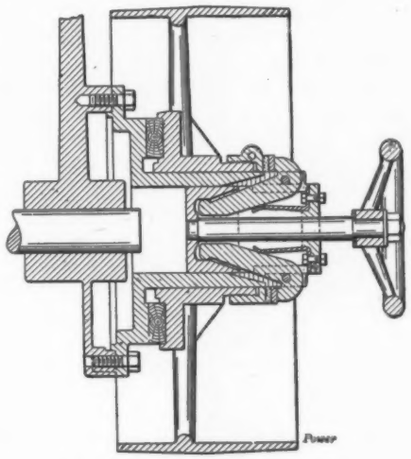


Fig. 48. Lemley Clutch

The Lemley gasolene-engine clutch is made by the W. A. Jones Foundry and Machine Company, Chicago, Ill.

Notes on Power Plant Betterment*

By H. H. Hunt

A consideration of the work of the engineering expert, who, through specialization in economic plant management, is able to introduce new methods which minimize waste and cut down operating expenses. To be effective, the regular operating force should be trained in these methods, which should be carried on with zeal after the expert leaves.

*From a paper presented at the Congress of Technology, at Boston, April 11, 1911.

The general tendency toward consolidation has extended to power plants, and many of the smaller ones have been replaced by large central stations of modern design, operated by high-priced men and with great refinement. There are, however, many of the smaller plants which for good and sufficient reasons are still in operation and which must be operated in the future. In the face of the upward tendency of wages, cost of apparatus and materials and the downward tendency of rates and increasing demands for improved service, the public service company of today is in a position where the question of economy all along the line, and particularly in that most important part of the property—the power plant, is one of vital importance.

A casual inspection of one of these small power plants often reveals a more or less heterogeneous collection of apparatus and machinery, some of which date back to the early days of the business. This, together with the fact that such a plant is usually operated by a force of engineers and firemen of only ordinary intelligence and ability, might naturally lead to the conclusion that, even under most favorable conditions, high power costs are to be expected.

On the other hand, a careful and detailed examination by an expert in power-station operation will almost invariably reveal many features which are capable of marked improvement, enabling him to report recommendations which, if properly carried into effect, will result in material reductions in costs.

In undertaking the betterment of operating conditions, attention should first be given to the personnel of the operating force. The chief engineer should be a man of both operating and executive ability, and capable of enforcing strict discipline. He must be capable of receiving instruction, as must also the other members of the force. Each man who does not possess the possibility of becoming a thoroughly efficient and alert member of the force should be replaced as soon as possible. Careful study is required in arriving at correct conclusions in reference to each individual of the operating force in order that justice may be done. It not infrequently happens that certain men develop unexpected ability as they gradually become familiar with the methods by which actual improvements are brought about. Furthermore, every reasonable opportunity should be given the existing employees to measure up to the new requirements in order to avoid the demoralization to the organization which would be caused by the needless discharge of men.

A thorough physical examination of the plant should be made and immediate steps taken to correct such defects as can be remedied without excessive cost. Starting with the fire room, for instance, the boilers should be thoroughly overhauled and cleaned, leaky tubes replaced,

blowoff cocks and valves made tight, gage glasses and dampers put in order, air leaks in boiler settings stopped, furnace linings, bridgewalls and grate bars put in order, safety valves adjusted, steam gages calibrated, etc. The work should be continued, in like manner, to the engines, paying particular attention to valve setting, steam piping, pumps, condensers, heaters, oiling systems and electrical machinery.

In connection with this general overhauling of the machinery, all gages, meters and measuring instruments should be calibrated and tested, so as to give accurate information regarding the operation of the plant. Attention should also be given to the matter of tools, and it should be seen that a suitable assortment is provided, both for the engine room and the fire room. Finally, the station should be thoroughly cleaned.

All the firemen should be individually instructed in handling the particular kind of coal used, in the use of the proper fire tools, the operation of the dampers and control of the draft. A thorough course of training along these lines will usually be found necessary, and it will be further necessary to instruct the chief and watch engineers in every detail of the proper handling of the fires in order that they may be able to maintain intelligent supervision over the room.

Special attention should be given to maintaining the necessary boiler pressure and feed-water temperature, in order to avoid the usual fluctuations which so largely affect station economy. Recording pressure gages and feed-water thermometers and a bulletin board in the boiler room, on which are posted the coal consumption and pressure records of each watch, will serve a useful purpose in exciting rivalry among the men.

Presumably, the engineers understand such matters as the starting and stopping of their engines and generators; nevertheless, the expert should give some attention to the engine room. In this connection a most careful study of the load conditions should be made and charts prepared which will show clearly just what combinations of apparatus and machinery should be used to meet the various conditions of the load, the idea being to so arrange the schedules that each piece of apparatus, when in use, will be operated as nearly as possible at its point of maximum efficiency.

A carefully arranged station log should also be provided which will contain the daily operating data of the plant, recorded in a systematic manner. In such a station log it is desirable that the main factors, such as coal consumed per kilowatt-hour, water evaporated per pound of coal, etc., be shown so clearly that the manager of the company, by spending a few minutes daily in perusing the station log, may become fully acquainted with the daily operation of the plant and be in position to intelligently discuss matters with his chief engineer.

The coal problem is one of the most important, and at the same time one of the most troublesome, which is encountered in power-plant operation. The quality of coal depends, to a certain extent, upon the location of the power plant as related to the sources of coal supply. It will be found profitable to have a careful investigation made of the possible sources from which coal may be secured at reasonable prices. Full data should be gathered regarding the analysis of the various coals available, and that coal selected which will meet local conditions with the best results. While not always practicable, it is desirable to purchase coal on the analysis basis under specifications which provide for a penalty or bonus according to whether the coal falls short of or exceeds the requirements of the contract. Under such a contract an analysis of each shipment of coal is necessary. Where the annual consumption is comparatively small, however, it is not practicable to purchase coal on the analysis basis, in that event the best that can be done is to buy it of responsible dealers who handle the best coal to be had under the circumstances.

To account for the coal purchased, while seemingly simple, proves in practice more or less troublesome. Coal is frequently purchased and paid for according to bill of lading weights. The consumer is apt to suffer shortage under this method of purchase and to start out with substantially less coal in than is called for by his books. It is obvious that ultimately the cost of the coal consumed must check with the cost of coal purchased, and in order to bring about this agreement, frequent checks between station records, coal on hand and fuel accounts are necessary. It will be found desirable to arrange proper scales for weighing in bulk the coal which is delivered to the yard; and if a contract can be so arranged as to make payments on the basis of the company's weights, one question of coal shortage will be removed. Bins should be provided which will permit the coal supply to be accurately measured at any time. Also the coal passing into the fire room must be carefully weighed and these weights recorded. With these precautions there should be no excuse for coal shortage.

Low cost of maintenance does not always indicate thorough or economical maintenance, for while it may be possible to run for months on abnormally low maintenance costs, the time will come when the accumulation of deferred maintenance will produce a condition of affairs which will require excessive expenditures, if not for new apparatus, certainly for the overhaul and repair of the old apparatus. Therefore, it is desirable to prepare a proper maintenance schedule which shall be carefully and conscientiously followed by the operating force. Such a schedule will set forth definite dates for the inspection of all apparatus; the schedule to be so arranged that each and every part will receive periodical attention as often as is necessary to keep it in good operating condition.

As to what may be expected as a result of this power-plant betterment work, it may be summed up as follows: first, accurate knowledge of the maximum efficiency of which the particular plant under consideration is capable; second, the securing of this efficiency through the efforts of a well trained and efficient operating force; third, systematic and economical maintenance producing maximum life of all apparatus and continuity of service; fourth, in case of failure to continue to produce the desired results, it is possible to trace the cause.

Experience has shown that the saving in power costs, resulting from power-station betterment work, will cover the cost of the necessary expert services in a comparatively short time, depending upon the amount of saving effected.

The continued operation of a power plant under the conditions established by successful betterment work, by which maximum economy in operation and maintenance are secured, calls for most active and energetic work on the part of the operating force. In fact, from the manager of the company all along the line down to the coal passers, every man must work under high pressure. After the novelty of the improved condition wears off, the operation of the plant becomes not only monotonous but exceedingly strenuous. It is so much easier to slip back a little than to maintain the required pace, that frequent checking of the plant operation is necessary. The manager must give his personal attention to this matter, and he will doubtless be surprised to note the effect of his failure to carefully follow up the matter of daily checking of the plant, if for any reason it becomes necessary for him to temporarily discontinue his critical study of the daily station log.

In spite of all reasonable efforts, it is quite likely that the economy of a plant will gradually decrease because of a combination of little things which creep into the operation unnoticed by the engineers. This has been noted in actual experience and has led to the belief that a periodical power-plant audit by a competent expert is necessary just as it is found necessary to periodically audit the accounting department. Such an audit will require much less time than the original examination, especially if both examinations and audits are made by the same man, and should not, therefore, be very expensive.

Limitations of Scientific Efficiency

By Henry G. Bradlee

While recognizing that the efficiency engineer can improve operating and manufacturing methods in certain instances, the author calls attention to the limitations in this line and cites cases where the cost of reorganization and the introduction of new methods far exceeds the benefits derived therefrom.

*From an address delivered before the Congress of Technology, and also the National Association of Cotton Manufacturers.

During the past year much has been said and written about "efficiency," and, in fact, quite recently the public was startled by the statement that the steam railroads of this country are wasting a million dollars a day—three hundred and sixty-five million dollars a year—which might be saved through the adoption of so called scientific methods of management.

This whole question has recently jumped into prominence because a group of men, who have been doing some very excellent and successful work, have been tempted into the realm of prophecy, and have possibly allowed their enthusiasm to outstrip their judgment.

In view of the statements which have been made it certainly seems reasonable to consider whether there are not some practical limitations which have prevented a general adoption of these methods in the past and which may prevent the wholesale overturning of present industrial systems.

Stripped of technicalities the method of the modern efficiency engineer is simply this. First, to analyze and study each piece of work before it is performed; second, to decide how it can be done with a minimum of wasted motion and energy; third, to instruct the workman so that he may do the work in the manner selected as most efficient. There is nothing fundamentally new in this method. The underlying principle is being used today to a greater or less extent in all industries and has, no doubt, been used at all times in the past.

The method as employed by the modern efficiency engineer is distinctive, not because it is new, but because it is carried to much greater detail. He is not content to plan work along broad general lines, but proposes to attack it in a more scientific spirit and obtain maximum efficiency through prevailing waste and loss at each and every point. With this in view he watches every motion of the workman's hands and body. If any unnecessary movement is made he tries to change the conditions under which the work is carried on or gives instructions to the workman so that the wasteful act may be avoided in the future.

The form of organization adopted naturally has the same end in view. The number of overseers, supervisors, experts and specialists, in proportion to the number of workmen, is materially increased. Special accounting systems are adopted to show at a glance what proportion of the cost of a piece of work is necessary and what proportion is caused by wasted energy. The information so obtained is used as a guide to prevent waste in the future. The workman is often encouraged to coöperate through the use of a bonus system which aims to give the highest pay to the most efficient worker.

These methods in certain cases have produced surprising and satisfactory results, but it is by no means a necessary conclusion that they can be universally applied with equal success.

Upon considering these methods of careful study and analysis, and of detail instructions to workmen, one is first impressed by the fact that such study and instruction must be expensive; it must be performed by men of considerable ability, and consequently high pay, otherwise it will not be effective. Such methods, therefore, can be used to advantage only where a material saving can be made.

If a piece of work is to be performed but once the manner in which it is to be done may be planned in a general way, but should one attempt before starting the work, to decide the exact manner in which every detail is to be handled the cost of planning may exceed any possible saving in the cost of labor. If the work is to be repeated several times, but each time is to be performed under new conditions, the same difficulty will be found. On the other hand, if the work is to be repeated a number of times under uniform conditions, instead of only once, it may be profitable to carry out the preliminary planning in greater detail, but not until the work is to be repeated over and over again should the full program of the efficiency engineer be adopted.

Next, consider the territory covered by the work of any industrial organization. Imagine a factory employing a thousand men under a single roof. Then imagine an industry employing an equal number of men distributed through forty different cities, an average of twenty-five men in each city. Can there be any doubt that the introduction of the methods of scientific efficiency would be fraught with a hundred difficulties in the second case for every one in the first?

To what class of work, then, may efficiency methods be successfully applied? Work of this character will presumably be found in certain large mills, factories and shops and in some special departments of other industries. In fact, from the examples quoted by these engineers it is in just such places and under such conditions that the best results have been secured.

But this is only one side of the problem; further study will show that even where conditions are favorable to efficiency methods limitations often exist which will prevent their adoption.

Low cost of operation or of manufacture, is, after all, only one factor out of many to be considered in measuring industrial efficiency. It frequently happens that the lowest cost can only be secured through sacrificing other and more important factors; for example:

Steam railroads increase their operating costs per ton mile by operating express service. By doing this they have helped to build up industries which could not otherwise exist. People are glad to pay this extra cost so that they may no longer be dependent upon a local supply of fruits and other perishable goods.

In construction work methods are frequently adopted which might be considered extravagant if the advantages which come from completion of the work by a certain date were overlooked. Delay in completion is often far more serious than a considerable increase in the cost of the work.

An electric lighting company will spend a large amount of money to purchase and maintain a storage battery solely to prevent momentary interruptions to service. Continuity of service, even at increased cost, is necessary to retain public good will and patronage.

It is often more economical for a street railway to attach trailers to its regular cars to handle rush hour business than to operate additional cars. The public, however, do not like trailers and, here again, the railway decides that public good-will is more important than a slight saving in expense.

These few examples illustrate that diversified industries, public health, safety and welfare, speed of action, time of completion, quality and quantity of service, public good will and patronage, all enter into the measurement of success and efficiency.

Moreover, an attempt to increase economy in one detail of operation often decreases it in another. This may be illustrated by the fact that one of the first steps taken by an efficiency engineer is

to establish an elaborate system of cost accounting; a second step is to increase the number of supervisors and specialists employed to oversee and direct the work of the laborers. This increased cost is deliberately and intentionally incurred for the purpose of saving a greater amount in other items of expense. If the accounting department were considered by itself without reference to the rest of the business, or if the number of supervisors and specialists were compared with those employed by some other concern doing a similar business, it might appear that the efficiency engineer is most extravagant and uneconomical. However, to be fair and just to the engineer, one must consider the results of his work as a whole and not condemn him because of increased expenses in certain departments.

It has always been recognized that there is an element of danger in fixing one's attention too closely on detail economies, which is in line with the "man who was penny wise and pound foolish." The writer once knew the manager of an electric lighting company who directed his business with the greatest economy. He frequently remarked that he would much rather save a dollar in operating expenses than secure a dollar of new business because, when he had saved a dollar in expense he had saved the whole dollar, but, when he had obtained a dollar from new business he had to spend half of it in serving the customer. In due course of time this manager resigned and a new man was appointed in his place. The new manager was not very economical, but he was a hustler for new business and he kept in very close touch with his customers. As a result the business immediately began to grow and increased very rapidly, and the public received more and better service at slightly lower rates. The dividends of the company increased, but the cost of operation per kilowatt-hour increased also. Measured by operating costs only, the efficiency was less than under the old manager, but the efficiency of the business, as a whole, was greatly increased.

The question will naturally be asked—why not secure a manager who will push the development of the business, keep the public satisfied, maintain a high quality of service, and, at the same time, direct his organization and business along the lines of maximum economy? There is no doubt that men of this kind would be desirable but, unfortunately, they are few and far between.

Flow of Water in Clean Iron Pipes

By Albert E. Guy

The method of developing and plotting a chart showing the flow in gallons per minute for any size of pipe between 2 and 72 inches with a velocity anywhere between 0.5 and 25 feet per second. An introductory discussion and a similar chart, applicable between different limits, appeared in the April 4 issue.

It is not possible for an investigator to cover in experiments the complete range of conditions with which the practical engineer has to deal at some time or another; this is particularly true with hydraulics. Prior to Darcy's investigations of the subject, many experiments on the flow of water in pipes had been conducted, but the results were not coherent until Prony, of the Prony brake fame, took up the problem, and finally succeeded in establishing a complex formula with constant coefficients, which embodied approximately all the experimental results at hand at that time. Prony's achievement appeared to many engineers more as the result of an accidental compensation between all the causes of divergence than as the revelation of a positive law.* Darcy's experiments confirmed the deductions of Prony and enabled him to simplify the latter's formula.

More recent investigators, however, have endeavored to establish a formula still less complicated than Darcy's. This complication, so far as concerns the present treatment, lies in the fact that each pipe diameter is expressed in the complex form,

$$\frac{D}{\sqrt[6]{0.62\,(D+1)}}$$

It would be very desirable to have, instead of this, one of a simpler form D^n.

Several engineers have boldly cut across lots, and have each brought out a formula which, expressed by a graphical chart of the type described here, has for the diameters a continuous scale much easier to establish than that of chart No. 1.† Besides, the diameter function being continuous, it was possible to show on the same chart an additional scale, very much needed, giving the velocity per second corresponding to a given quantity of water passing through a pipe of certain diameter.

It is easy to so transform Darcy's formula that D becomes a continuous function; but in order to do this, an approximation must be introduced. Solving the expression $\left(\frac{D}{\sqrt[6]{0.62\,(D+1)}}\right)$ for a series of values of D ranging from 2 to 48 inches, and then considering each of the values obtained thereby as representing the corresponding diameter raised to a certain power, the expression may be written,

$$\frac{D}{\sqrt[6]{0.62\,(D+1)}} = D^n$$

or, using logarithms

$$\frac{\log.\left(\frac{D}{\sqrt[6]{0.62\,(D+1)}}\right)}{\log. D} = n$$

For the range of diameters considered, n appears to be almost constant; that is, n increases from 0.851 for a diameter of 2 inches, to 0.864 for one of 4 inches, and then gradually decreases until it becomes 0.852 for a 48-inch pipe. The average value is 0.8567, which permits Darcy's formula to be written with a very close approximation, as follows:

$$\text{Gallons per minute} = (D^{0.8567})^3 \sqrt{h} \quad (13)$$

or,

$$\text{Gallons per minute} = D^{2.57} \sqrt{h} = D^{1.8}\sqrt{h} \quad (14)$$

However, the writer preferred to make chart No. 1 conform strictly to Darcy's original formula and to construct chart No. 2, showing the relation between the volume and the velocity of water passing through a given pipe.

Let

V = Velocity in feet per second;
D = Diameter of pipe, in inches.

The area of the pipe, in square feet, is:

$$\frac{\pi D^2}{4 \times 144}$$

The velocity in feet per minute equals $V \times 60$.

One cubic foot equals 7.48 United States gallons.

Substituting these values,

$$\text{Gallons per minute} = \frac{\pi D^2}{4 \times 144} \times 60 \times V \times 7.48 = \frac{D^2 V}{0.4085} \quad (15)$$

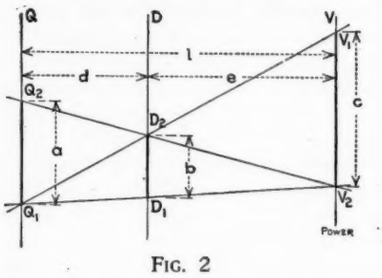
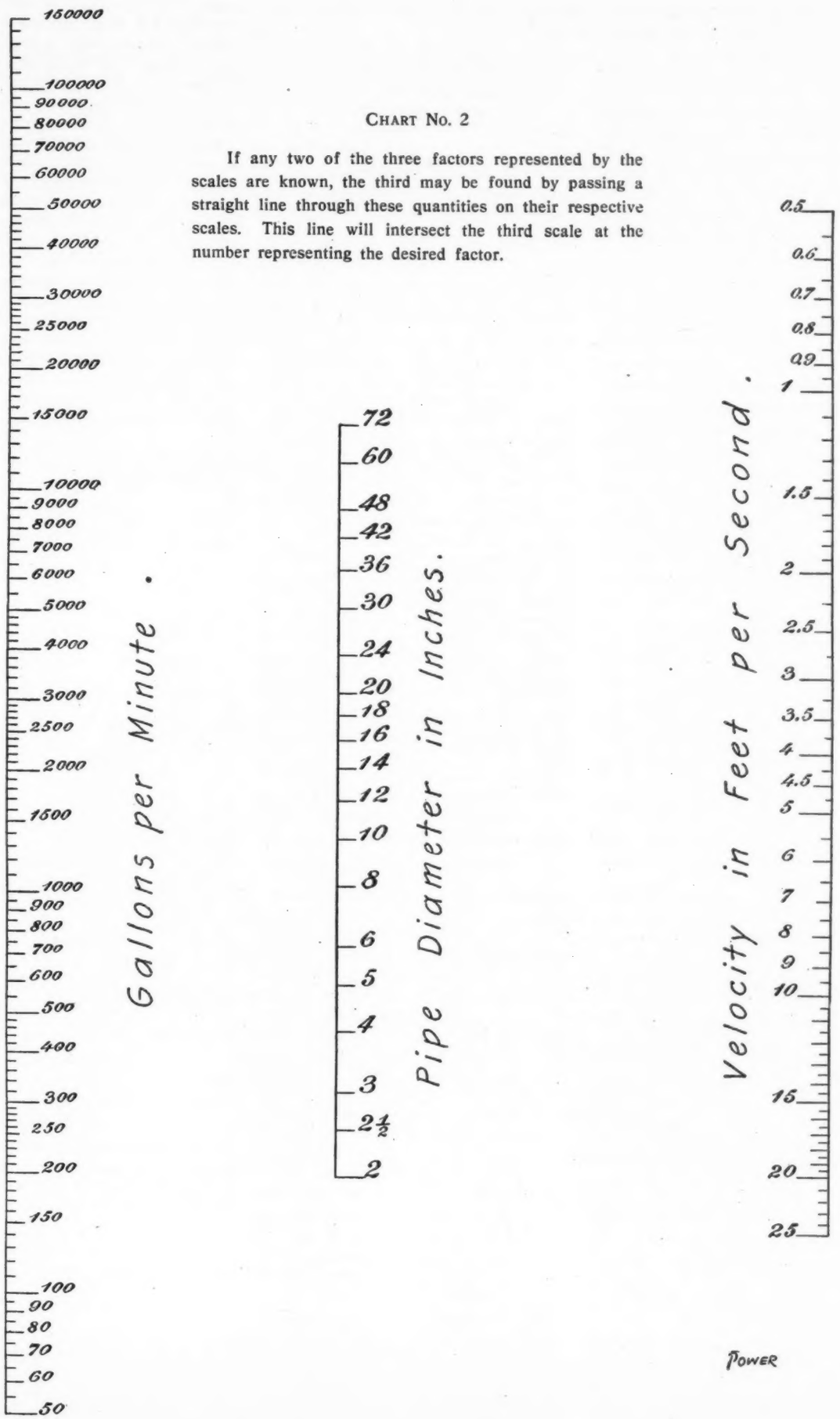


FIG. 2

*E. Collignon, "Hydraulique."
†Chart No. 1 appeared in the April 4 issue of POWER.

Chart No. 2

If any two of the three factors represented by the scales are known, the third may be found by passing a straight line through these quantities on their respective scales. This line will intersect the third scale at the number representing the desired factor.



The chart is intended to cover a range of volume from 50 to 150,000 gallons per minute, for pipe diameters from 2 to 72 inches, the velocity ranging from ½ foot to 25 feet per second.

Proceeding as with chart No. 1, let Fig. 2 represent the chart to be established. On three parallel lines Q, D, V, it is proposed to lay off scales such that on Q will be read gallons per minute; on D, the diameter of the pipe in inches, and on V, the velocity in feet per second. Now, any straight line such as $Q_1 V_1$ placed across the three scales is to indicate that a quantity Q_1 in gallons per minute, will pass through a pipe of diameter D_2, with a velocity of V_1 feet per second.

Assume that the scale of numbers on a slide rule measures exactly 10 inches. Such a length may be understood to represent the value of the number 10. The values of the numbers 2, 3, 4, 5, would be represented, according to logarithmic tables, respectively, by 3.0103, 4.7712, 6.0206 and 6.9897 inches. Adding the lengths representing 3 and 4, the result is

$$4.7712 + 6.0206 = 10.7918 \textit{ inches}$$

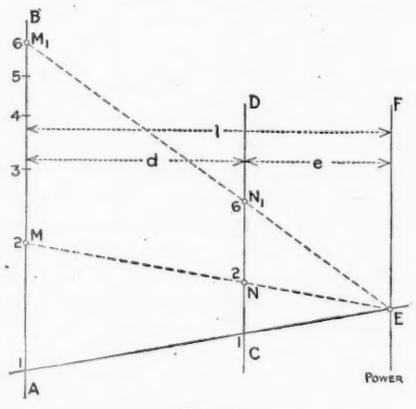


FIG. 3

This length represents the value of the number 12.

In Fig. 3, the three parallel lines $A B$, $C D$ and $E F$ represent scales of the same kind as used on the slide rule, the origin of each scale being at the intersection with the datum line $A E$. The three scales being fixed, if the line $A E$ is made to pivot about point E and occupy successively the positions represented by the dotted lines $M E$ and $M_1 E$, it will cut on $C D$ the lengths $C N$, $C N_1$, respectively proportional to $A M$, $A M_1$; and if the length $A M$ represents the logarithm of the number 2 and $A M_1$ that of 6, the lengths $C N$ and $C N_1$ will represent these numbers respectively on a smaller scale.

The logarithm of 10 may be drawn on $A B$ with a modulus, or length in inches or millimeters equal to m_1; on $C D$ with a modulus equal to m_2, and on $E F$ with a modulus equal to m_3. Let $A M$ represent the logarithm of 2, and $A M_1$ the logarithm of 6; then,

$$\begin{aligned} log.\ 2 \times m_1 &= A M \\ log.\ 6 \times m_1 &= A M_1 \\ log.\ 2 \times m_2 &= C N \\ log.\ 6 \times m_2 &= C N_1. \end{aligned}$$

But,

$$\frac{A M}{C N} = \frac{l}{e} = \frac{log.\ 2 \times m_1}{log.\ 2 \times m_2}$$

$$\frac{A M_1}{C N_1} = \frac{l}{e} = \frac{log.\ 6 \times m_1}{log.\ 6 \times m_2}$$

Hence,

$$\frac{l}{e} = \frac{m_1}{m_2}$$

When pivoting the straight line $A E$ about point E it was first stopped at M,

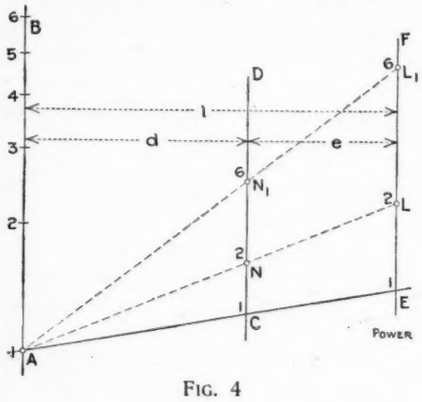


FIG. 4

determining on scale $A B$ a length $A M$ equivalent to the logarithm of 2; at the same time determining on scale $C D$ a length $C N$ also equivalent to the logarithm of 2, but of length

$$C N = e \times A M$$

If $A M$ represents the logarithm of 2, and $A M_1$ represents the logarithm of 6, then $M M_1$ represents the length of the logarithm of 3. Hence, just as with the slide rule, when different lengths are added on one scale, the total length represents the product of the numbers represented by these lengths.

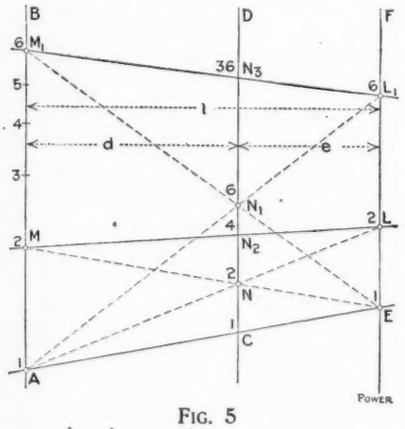


FIG. 5

Fig. 4 has the same and similarly placed scales as Fig. 3. By pivoting the straight line $A E$ about point A and stopping first at point N, the length $E L$ is determined on $E F$. It is evident, from the foregoing, that $E L$ represents, on a large scale, the same logarithm that is represented by $C N$; hence:

$$\frac{E L}{C N} = \frac{l}{d} = \frac{log.\ 2 \times m_3}{log.\ 2 \times m_2}$$

whence,

$$\frac{m_3}{m_2} = \frac{l}{d}$$

The same reasoning holds true for points N_1 and L_1.

Fig. 5 is a combination of Figs. 3 and 4. Here, the straight lines $E M$ and $A L$, starting respectively from the origin of the scales $E F$ and $A B$, and intersecting at a common point N on $C D$, determine on the three scales the lengths $A M$, $C N$, $E L$, which represent the logarithm of the same number. Similarly, lines $A L_1$, $E M_1$, intersecting at N_1 on $C D$, determine the three lengths $A M_1$, $C N_1$, $E L_1$, each representing the logarithm of the number 6. By joining M and L a length,

$$C N_2 = C N + N N_2$$

is cut. But $C N$ is the logarithm of 2, and obviously $N N_2$ is also the logarithm of 2, for

$$\frac{E L}{N N_2} = \frac{E L}{C N} = \frac{l}{d}$$

therefore,

$$C N_2 = log.\ 2 + log.\ 2 = log.\ 4.$$

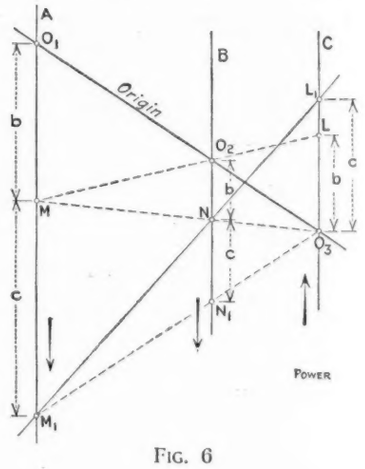


FIG. 6

By joining M_1 and L_1 the length

$$C N_3 = C N_1 + N_1 N_3$$

is cut on $C D$. But,

$$C N_1 = N_1 N_3,$$

and

$$C N_3 = log.\ 6 + log.\ 6 = log.\ 36.$$

However, the scales do not always run in the same direction; they may run in opposite directions. Generally speaking, a three-line diagram is intended to solve an equation of the form:

$$a = constant \times b \times c$$

where a, b and c are the variables. Passing to logarithms, and neglecting the constant,

$$log.\ a = log.\ b + log.\ c$$

If b is on the first scale and c on the third, b added to c must equal a (as read on the middle scale). In this case, as shown by Fig. 5, the three scales are graduated in the same direction.

If a is on the first scale, b on the second, and c on the third, the problem seems, at first, a little more complex. These scales are shown in Fig. 6. Line O_3M cuts O_2N on scale B, and O_1M on scale A; each of these two lengths, as measured on its own scale, represents the same number, b. Similarly, length O_3L, determined on scale C by line ML, represents the same number b. Let O_3L_1 equal c, then line L_1M_1, passing through N, cuts on scale A the length O_1M_1 equal to $O_1M + MM_1$; or, as stated before, O_1M_1 represents *log.* b + *log.* c, or the product $b \times c$. In this instance, the two scales, A and B, are graduated in the same direction, while the other, C, is inverted. The position and direction of the scales depend obviously upon the conditions of the problem at hand which they are intended to solve.

Reverting now to Fig. 2 and equation (15), let

$Q_1 = 1000$ *gallons per minute;*
$Q_2 = 10{,}000$ *gallons per minute;*
$D_1 = 8$ *inches.*

Neglect the constant factor (0.4085) for the present. The formula then becomes

$$Q = D^2 V$$

$$Q_1 = 1000 = 8^2 \times V_2$$

$$V_2 = \frac{1000}{64} = 15.625 \text{ feet } (log. = 1.19382)$$

With this value of V_2

$$Q_2 = 10{,}000 = D_2^2 \times V_2 = D_2^2 \times 15.625$$

$$D_2 = \sqrt{\frac{10{,}000}{15.625}} = 25.298 \text{ inches}$$

$$(log. = 1.40309)$$

To obtain V_1

$$1000 = 25.298^2 \times V_1$$

$$\frac{1000}{(25.298)^2} = V_1 = 1.5625 \text{ feet } (log. = 0.19382)$$

It is now possible to write:

$a = (log.\ Q_2 - log.\ Q_1)\ m_1 = (4 - 3)\ m_1 = m_1$

$b = (log.\ D_2 - log.\ D_1)\ m_2 = (1.40309 - 0.90309)\ m_2 = 0.5\ m_2$

$c = (log.\ V_2 - log.\ V_1)\ m_3 = (1.19382 - 0.19382)\ m_3 = m_3$

Because of the similarity of the four triangles,

$$\frac{a}{b} = \frac{l}{e} \text{ and } \frac{c}{b} = \frac{l}{d}$$

whence,

$$ae = cd \text{ and } \frac{a}{c} = \frac{d}{e}$$

There remains only to determine the moduli. For convenience m_1 was taken equal to the length of the scale of cubes on a 10-inch slide rule, and m_3 equal to the length of the scale of squares, that is, respectively 83⅓ and 125 millimeters. Then,

$$\frac{a}{c} = \frac{d}{e} = \frac{m_1}{m_3} = \frac{83\frac{1}{3}}{125} = \frac{2}{3}$$

whence,

$$d = \frac{2e}{3} \text{ and } l = e + d = e + \tfrac{2}{3}e = \tfrac{5}{3}e$$

$$\frac{a}{b} = \frac{l}{e} = \frac{m_1}{0.5\,m_2} = \frac{\frac{5}{3}e}{e}$$

$$m_1 = \tfrac{5}{3} \times 0.5\ m_2 = \tfrac{5}{6}\ m_2$$

With

$$m_1 = 83\tfrac{1}{3}$$

$$m_2 = \frac{83\frac{1}{3} \times 6}{5} = 100 \text{ millimeters}$$

In constructing Chart 2, the elements adopted were:

$m_1 = 83\frac{1}{3}$ *millimeters* $\quad d = 68$ *millimeters*
$m_2 = 100$ *millimeters* $\quad e = 102$ *millimeters*
$m_3 = 125$ *millimeters* $\quad l = 170$ *millimeters*

One point on the diameter scale was figured out for a given quantity and a given velocity, taking then the constant factor into account, the location of the origin of the scale was thereby determined. This scale of the modulus equal to 100 millimeters was laid out by projecting an ordinary slide-rule scale of a modulus equal to 125 millimeters.

The attention of the reader is called to the fact that, although Chart 2 is correct, and correctly drawn according to the foregoing calculations, it does not seem to meet the requirements exemplified by Fig. 5. The trouble seems to be with the D scale. However, the discordance is more apparent than real; it exists because the pipe diameters themselves, such as 6, 8, 10 and 12 inches, are marked; but it ceases when it is known that the exact numerical values represented by each of these sizes is really its square. Thus, 6, 8, 10 and 12 inches represent respectively 36, 64, 100 and 144. With this correction the chart agrees entirely with Fig. 5. The point raised, however, is so important that it will be taken up again in Part III, where the general formulas applying to this kind of diagram will be shown and demonstrated.

Gears for Steam Turbines

The Hon. Charles A. Parsons, in a recent lecture before the Royal Institution, spoke interestingly regarding the use of gears upon steam turbines, and exhibited the pinion which had been used to transmit 900 horsepower to the propeller of the "Vestasian" while making over 12,000 miles. The evidences of wear were very slight, and it was said that the drive had been entirely successful. As compared with the original machinery, the geared turbine had shown an economy of 22 per cent. with the same boilers and propeller. The turbine is run at 1400 revolutions per minute, and the speed is reduced by gearing to 70 at the propeller. The efficiency of the gear is very high. Measurement of the rate at which heat is generated indicates that it is over 98.5 per cent., and the friction is too small to be satisfactorily measured with a transmission dynamometer. In marine use the geared turbine is very effective in preventing racing, as the inertia of the swiftly rotating parts prevents a material increase of speed, even when the propeller is raised out of the water.

German Market for Lubricants

According to Consul General Robert P. Skinner, of Hamburg, in the *Daily Consular and Trade Reports*, there is an extensive demand in Germany for lubricating materials of every description. Such as are obtained from the residues of the distillation of mineral oils containing paraffin, or are of a tarry or pitchy nature, the latter provided that they do not sink in water, are dutiable in Germany at the rate of $1.428 per 220 pounds. Other lubricants, manufactured with fats or oils, liquid or solid, molded into shapes or not, are dutiable at the rate of $1.785 per 220 pounds.

Some difficulty attends the importation of lubricants manufactured from fats or oils, for the reason that such products must be denatured, upon arrival, with petroleum.

Various American concerns are engaged in all branches of this business, usually having well organized Hamburg branches to handle the trade at first hand, and apparently with successful results.

The introduction of a new American grease would be difficult, but by no means impossible. Quality, special advantages and price might sell it, if energy and perseverance were manifested by the exporters in entering the market, and intending exporters should ascertain whether an identical or very similar article is not already on sale in Germany.

It would also be advisable that the intending exporter obtain samples and prices of different lubricants of the same class manufactured or sold in Germany and study the comparative merits of each. The exporter should send a competent representative to the German market to work out the practical details of securing a sale for his product for himself. An article of this kind is almost impossible to place by means of ordinary correspondence.

The imports into Germany of lubricating oil, paraffin, vaseline and vulcan oils during the first 11 months of 1910 amounted to 202,052 tons, valued at $6,559,280, as compared with 191,366 tons, worth $6,212,276, for the corresponding months of 1909. Of the quantity imported in 1910, the United States supplied 90,894 tons, Asiatic Russia 63,527 tons, Austria-Hungary 29,090 tons, European Russia 16,083 tons and Belgium 1614 tons. The German imports of lubricants manufactured from fats and oils during the first 11 months of 1910 amounted to 7419 tons, valued at $547,400, against 6963 tons, worth $513,842, for the same period of 1909. Of the quantity imported during 1910, the United States supplied 5868 tons, an increase of 208 tons over 1909. Thus in 1910 the United States supplied 45 per cent. of the mineral oils imported by Germany and 79 per cent. of the oils made from fat.

Electrical Department

Especially conducted to be of interest and service to the men in charge of the electrical equipment

A Difficult Case of Parallel Operation

By H. R. Mason

The parallel operation of 60-cycle alternating-current generators, especially of the older types, often presents very interesting problems to solve. The station in which the following difficulties were encountered is of about 12,500 kilowatts capacity, about 3500 kilowatts being in 600-volt direct-current railway generators and the others 60-cycle 2300-volt alternators supplying rotary converters to a capacity of about 4500 kilowatts and an alternating-current lighting and power system of about 4500 kilowatts.

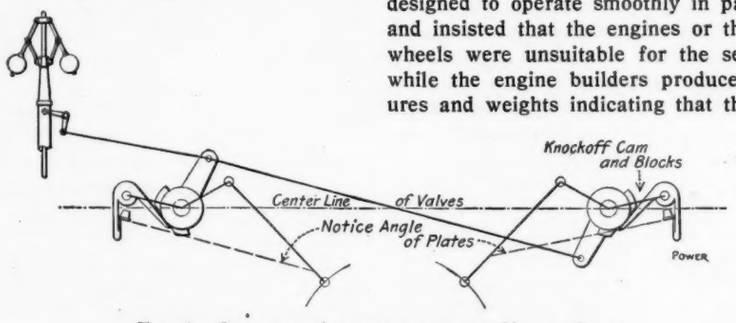


Fig. 1. Original Arrangement of Valve Gear

There are two 1500-kilowatt alternators, one driven by a 36 and 60 by 60-inch cross-compound Corliss engine and the other by a 36x60-inch twin Corliss engine; also, two 3000-kilowatt turbine units. It was found impossible to secure satisfactory parallel operation of the engine-driven units with each other or with the turbines and it was accepted as an impossibility for some years, as the load was not so heavy that parallel operation was absolutely necessary. There was no difficulty in getting the two turbines to operate in parallel with each other and, as there are two sets of busbars, the load could always be divided so that the two turbines were on one set during the peak while one engine unit on the other set carried the city arc lamps and enough rotary converters to take care of the remainder of the load. This was often troublesome and expensive, as it resulted in an unsatisfactory engine load at times and required close attention in balancing the load between the two sets of busbars.

The load recently increased to such an extent that it became imperative either that the alternators be made to operate in parallel, or that a third set of busbars be installed so that the remaining engine could be operated, which meant considerable expense and undesirable complication. The builders of the alternators maintained that the machines were designed to operate smoothly in parallel and insisted that the engines or the flywheels were unsuitable for the service, while the engine builders produced figures and weights indicating that the engines were not to blame and claimed that the generators were deficient in synchronizing ability.

Upon trial, it was found that no matter how carefully the generators were got into synchronism they would set up enormous cross currents within a revolution or two after being connected to the same busbars and it had happened a number of times that rotary converters were caused to flash over and interrupt part of the service in the brief time required to change the switches in transferring the load from one alternator to another.

Indicator diagrams were taken, which disclosed some serious faults in the steam distribution, due to unequal cutoff and unequal and excessive compression. In this connection, there is a point which seems never to have been taken into consideration in all of the endless arguments for and against compression, and that is its effect upon the angular velocity of the flywheel. In this case the compression figured up to nearly 600 horsepower, which seemed an unreasonable amount even for a 2000-horsepower engine, and as this energy was necessarily absorbed from the flywheel near the end of the stroke, it was thought to be at least partly responsible for the trouble in operating the units; therefore, the eccentrics were moved so as to give much less compression and the cutoff was equalized as far as possible.

After taking additional indicator diagrams it was found that the governor rods were connected to the knockoff cams at unequal angles, the undesirable method of connection shown in Fig. 1 being used. With this kind of connection, it is impossible to adjust the cutoff of the crank-end valve without disturbing the adjustment of the head-end valve, and in this case the unequal angles of the knockoff cams caused the point of cutoff to change at different rates on the two ends of the cylinders, which also added to the trouble in paralleling the generators.

Upon still closer examination of the valve gear it was observed that the latch plates were set at an improper angle, as also represented in Fig. 1, frequently causing the block to slip off the hook before the tail of the hook struck the knockoff cam; although this could scarcely be observed by watching the engine, it showed on the indicator diagrams and resulted in unequal crank efforts. Another effect of the latch plates being set at an incorrect angle was that the springs had to be kept at a very strong tension, which resulted in a severe shock being transmitted to the governor mechanism every time the hook encountered the knockoff cam. These defects were all corrected and the valve gear changed to the arrangement shown in Fig. 2, which gave reasonably good indicator diagrams.

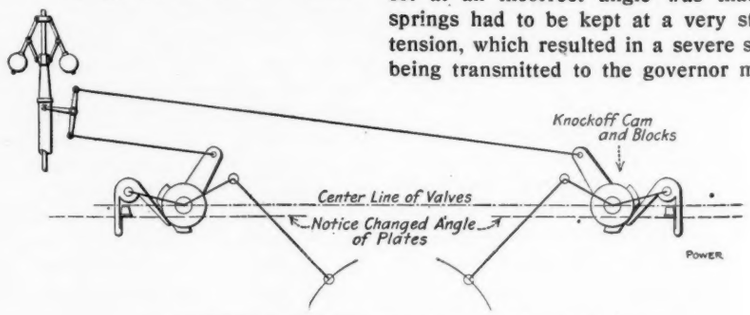


Fig. 2. Corrected Arrangement of Valve Gear

After this was done, determined efforts were made to operate the units in paral-

lel, with partial success; closer attention was then given to the electrical part of the unit. It was found that either engine could be operated in parallel with the turbines, provided the field current of the engine-driven unit was greatly decreased, causing the output of the engine-driven unit to have almost unity power factor while the turbine unit would have a very low power factor, as it was then required to furnish practically all of the wattless component of the line current in addition to its load, but the two engine-driven units would operate in parallel with each other but little better than before. The supposition was that the field magnets of the engine-driven units were too close to the saturation point at any power factor much below unity, which would cause poor operation in parallel, as the reaction of the synchronizing current upon a field magnet is much less effective when the magnet is highly saturated. This impression was strengthened by the fact that on rare occasions the machines would run together for hours at a time at slightly reduced voltage, while a slight increase in field current would result in such heavy surges of cross currents that the machines would have to be separated immediately.

It was suspected for some time that the relative positions of the crank pins at the instant of synchronizing made a perceptible difference in the action of the generators, and considerable ingenuity was expended upon an electrical attachment to the engine shafts to indicate, through contact-making devices, when the cranks were in certain relative positions, but a large number of experiments indicated, so far as could be determined, that the relative positions of the crank pins made no difference whatever. When the power factor was favorable, 90 per cent. or higher, the generators would operate satisfactorily with the crank pins in any relative position, and when the power factor was much below 90 per cent. there was no position of crank pins with which they could be made to remain in parallel.

This, which at first appeared to be almost impossible to remedy, proved to be the simplest condition of all. It was reasoned that anything that would operate to maintain the necessary voltage without increasing the field current would assist in maintaining synchronism, and investigation developed that while the engine-driven alternators were rated at 78.5 revolutions per minute, they were running at about 77 revolutions per minute, or about 2 per cent. below speed. When the engine governors had been weighted down until the generators ran at 79 revolutions per minute, they operated in parallel perfectly under all changes in load and power factor. This required about 25 per cent. less field current and, incidentally, the increased speed and consequent higher frequency resulted in a much improved power factor on the entire system, which, of course, reduced the line losses and gave better voltage at remote points in the system.

It will be evident that no one item in the foregoing enumeration can be considered the reason that the alternators would not operate in parallel; correction of all of the deficiencies was necessary to obtain the result desired.

Improvements in Electric Lighting Properties*

By William H. Blood, Jr.

At the present time, when so much is being said about "efficiency" and "scientific management," it may be well to consider what the application of science to the electric-lighting industry has accomplished and to what extent the public has been benefited thereby.

In 1888, the writer tested the largest dynamo that the Institute of Technology possessed, and found the highest ratio of electrical output to mechanical input to be about 70 per cent. Today, machines of this size operate at about 85 per cent. efficiency, while larger units give efficiencies of 95 or even as high as 97 per cent. Assuming this improvement in efficiency to amount to an average of 25 per cent., it would mean that this percentage of the fuel which would have been burned, had there been no improvement in electrical efficiency since the year 1888, is now being saved.

If this figure is applied to the industry as a whole, basing the estimate upon figures given in the census reports on the cost of fuel used by the electric-light and railway plants in the United States, it shows that electrical engineers have brought about the conservation for future generations of approximately $12,000,000 worth of coal per year, and this solely on account of a single item—improvement in the efficiency of electric generators.

This improvement has been accomplished partly through an increase in the size of the units. The first commercial electric-light plant in Boston, built in 1886, contained six machines having an aggregate capacity of about 230 horsepower, two of them being of 15 horsepower each and the remaining four of 50 horsepower each. In 1888 the largest electric generators were of 100 horsepower, and they were regarded as monsters. Today, 15,000-horsepower machines are common and even units of 25,000 horsepower are about to be installed. The 25,000-horsepower generators, besides being more efficient, are much more reliable and are little, if any, more complicated than the older and smaller machines.

*From a paper delivered before the Technology Congress, at Boston, April 11, 1911.

One of the early electric-power plants with which the writer had some connection, contained twenty dynamos of 100 horsepower capacity each, giving a total capacity of 2000 horsepower, and the floor space required for the entire plant, including boilers and engines, was 9000 square feet, which is equivalent to 4.5 square feet per horsepower of capacity. This same company is today building a new station which is to have an ultimate capacity of 140,000 horsepower and which will require but slightly in excess of one-half a square foot per horsepower. The first plant represented an investment of approximately $225 per horsepower, while the new installation will cost about $45 per horsepower. Had there been no improvement made along this line, and had the company been obliged to increase its capital account on the basis of $225 per horsepower up to its present capacity, it would have required an additional investment of some $12,500,000, which would have entailed additional annual interest charges of $750,000.

A still further improvement in power-plant design has been the adoption of steam turbines. These, besides requiring much less room, use higher steam pressures and higher vacuums, and are, consequently, more efficient.

There has also been a great development in the boilers used in power stations. Instead of units of 100 to 125 horsepower, units of 600 horsepower are now in general use and boilers up to 2000 horsepower have been built. In the old tubular boilers 80 to 100 pounds was the common pressure used; this was later increased to 125 pounds, then to 150 pounds, and finally in the water-tube boilers of today 200 is commonly used. Improvements in superheaters, combustion chambers, automatic stoking devices, condensers, ash- and coal-handling machinery, apparatus for analyzing flue gases and other miscellaneous devices have all had their effect in cheapening the process of converting the heat units of coal into steam.

Turning again to the electrical equipment, the modern switchboard, although somewhat elaborate with its remote-control switches and automatic regulating and protecting devices, is simple of manipulation and arranged to give the plant the greatest flexibility of operation. With the increase in size of the units and the development of the modern switchboard, has come a decrease in the number of operators needed, so that today in the dynamo room of a 5000-horsepower plant there would be required only two or three men on a shift, whereas two decades ago eight or ten men would have been required.

In the early days of power-plant operation it required, as a rule, ten or more pounds of coal to produce one kilo-

watt-hour. In contrast to this, many modern stations are running upon about three pounds of coal per kilowatt-hour, and in some cases even less. This means that only 30 per cent. as much coal as was demanded twenty years ago is now needed to produce a unit of electrical energy.

In addition to the fact that the development of alternating-current apparatus has enabled the electric-lighting companies to distribute their product from the power station to the consumers at a much less cost, has also made it possible to transmit power for distances which were not dreamed of in the early days. Twenty years ago what little electricity was used was distributed by direct current and the radius of activity was seldom more than half a mile, or a mile at the most. This necessitated the generating stations being placed upon expensive land near the heart of the city, and since the voltage on a direct-current system is limited, it meant a large loss of power in transmission and required a large investment in copper. However, the introduction of high-voltage transmission has made it possible to locate factories, mills and shops at convenient places, instead as in the old days at or near the source of power, and has also greatly reduced the cost of distribution. These facts alone have had a wonderfully beneficial effect upon the entire industrial development of the country.

High-voltage transmission has further permitted the utilization of what were heretofore useless and almost inaccessible waterfalls. Without this development, Los Angeles would be forced to burn thousands of barrels of oil each day instead of using the mountain streams two hundred miles away, and Seattle would not be able to utilize the melting snow and ice from the glaciers of Mt. Rainier to operate all her street cars and other public utilities. Without high-voltage alternating-current apparatus, Niagara power could not be transmitted and used in the lake cities of Canada, or in Buffalo, Syracuse or Rochester. The utilization of Niagara power alone means a yearly saving of at least 2,500,000 tons of coal, or the conservation of $6,000,000 to $7,000,000 of fuel annually.

Consider now the apparatus by which the electricity is converted into light, heat and power. Here again scientific study and research have done much to increase the efficiency of the apparatus used. The reduced price of electricity itself, therefore, does not indicate the total saving to the consumer. Arc lamps of today are more than 100 per cent. greater in efficiency than those of a few years ago. Incandescent lamps in the early days consumed six watts of energy per candlepower. This consumption was soon reduced to three watts per candle, where it remained for many years and seemed to baffle further reduction, but after years of scientific experimentation this was reduced to 1½ watts per candle, and now there is the tungsten lamp which consumes only one watt per candle power; still further improvement is promised in a lamp which is to consume not over one-half a watt per candlepower.

While all of the matters thus far discussed relate to improvements which have taken place in the physical apparatus of the property, one must not fail to give due credit for the development of the electric-lighting industry, and for the reduction in the cost of light, heat and power, to the scientific management of electric-lighting properties. These have been specialized to a remarkable degree and carried on with most satisfactory results for many years, in spite of the fact that the term "efficiency engineer" is just becoming known to the public. The improvements in electric-lighting properties have been due fully as much to the trained engineer who operates the property as to the engineer who plans it or who designs the apparatus used in it. It is the operating engineer who in many cases has pointed out opportunities for betterment and has suggested to the designing engineer where economies and improvements could be made in the physical apparatus. It is the operating engineer who by careful study of men, machinery and methods has brought about economies in the production of electricity which have resulted in reduced costs. He has instructed his men in their particular duties and has educated them so that they have become experts in their lines.

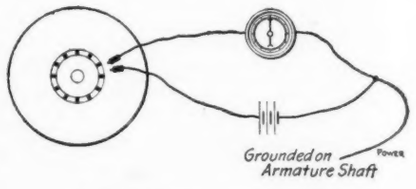
The operating engineer has not only brought about a great reduction in the cost of electrical energy itself, but as the result of a scientific investigation of the customer's needs he has effected, through the use of suitable electrical apparatus, what is in reality a still further reduction in the cost of light and power to the consumer.

The wonderful advance which has taken place in the last twenty years in the electric-lighting industry has been due to the combined efforts of the operating engineer and the designing engineer. It has been a gradual and a steady evolution and is still going on. The industry itself has not reaped all the benefits, for while the returns on electric-lighting investments have been sure they have not been as large as the dividends which the public has received in the reduced cost of electric light and power. Twenty years ago electric lights were high-priced luxuries, today they are inexpensive necessities.

LETTERS

Locating a Grounded Armature Coil

On page 420 of the March 14 issue, Mr. Davies describes a method of testing for the location of grounds in direct-current armature windings which is a good one. However, I think the method I have been using is simpler and easier of application. We have a good deal of this kind of trouble, caused by salt air attacking the copper and insulation, and the test has always been satisfactory. A millivoltmeter or galvanometer, a few cells of primary battery and a few short pieces of wire are all you need. Raise all brushes from the commutator and clean it thoroughly. Connect one terminal of the battery and one terminal of the galvanometer or millivoltmeter together and also to the armature shaft, as indicated



CONNECTIONS FOR TESTING

in the diagram. Then touch the two free terminals to one commutator bar and note the deflection of the instrument; if there is no deflection, one of the coils connected to that bar is dead grounded and that practically short-circuits the instrument and thereby prevents deflection. If there is a deflection, try another bar and note the deflection; if it is greater than the first one, you are moving away from the grounded coil. Successive tests will finally locate a bar where the deflection is smallest or where there is none; that bar will be connected to the grounded coil and by taking out the leads from the commutator bar and testing them separately the grounded coil will be easily identified.

A. I. WATSON.

U. S. S. "Michigan."

Smoothing Roughened Collector Rings

Cast-iron collector rings on revolving-field alternators are very hard to smooth after becoming rough from arcing. The "blisters" that have been raised are chilled and cannot be cut with a file. The best way I have found to deal with such cases is to grind a piece of an old emery wheel to the shape of the collector-ring brush, put it in one of the brush holders and run the machine, applying a little oil to the collector ring. It works like magic.

C. J. ARSON.

Dubuque, Ia.

Gas Power Department

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men

A Municipal Gas Power Pumping Plant

By Thomas E. Butterfield

A striking example of municipal progressiveness is embodied in the gas-power service and fire-pumping station installed within the past year by the town of Haddonfield, N. J. The new water-works system derives its water supply from four artesian wells which extend down about 220 feet. From each well a 6-inch branch leads to a 12-inch main extending from the well field to an absolutely water-tight concrete cistern 20 feet in diameter and 42 feet deep. The 12-inch main extends about 30 feet down into this cistern and as soon as the pumps lower the water level in the cistern more water is siphoned out of the wells.

The power house is built of hard burnt brick and the foundation walls are of concrete, reinforced according to requirements. Large double-width windows located between each pair of pilasters provide ample light and ventilation for the interior. The building is located at the foot of a hill, as shown in Fig. 1, and at the edge of a basin or depression in which the artesian wells were driven. The railroad spur track is on the crest of the hill and coal cars are dumped into the chute shown in the picture, the coal passing by gravity down the chute to the coal shed, whence it is wheeled by barrow across the bridge to the producer platform in the power house.

Fig. 1. Coaling Arrangement

The interior of the building is divided into two parts, the main producer floor and the pump pit. The producer floor is at the ground level and the floor of the machinery pit is located eight feet below and reached by iron stairways from the producer floor and the front of the building. An iron walkway along one side of the building (see Fig. 2) connects the front entrance with the producer floor. This iron walk also forms an excellent gallery from which the machinery on the floor below may be viewed.

As the floor of the machinery pit is five feet below the level of the ground water, it is constantly subjected to an upward pressure from beneath of over 300 pounds per square foot. To withstand this the floor was constructed of concrete several feet thick.

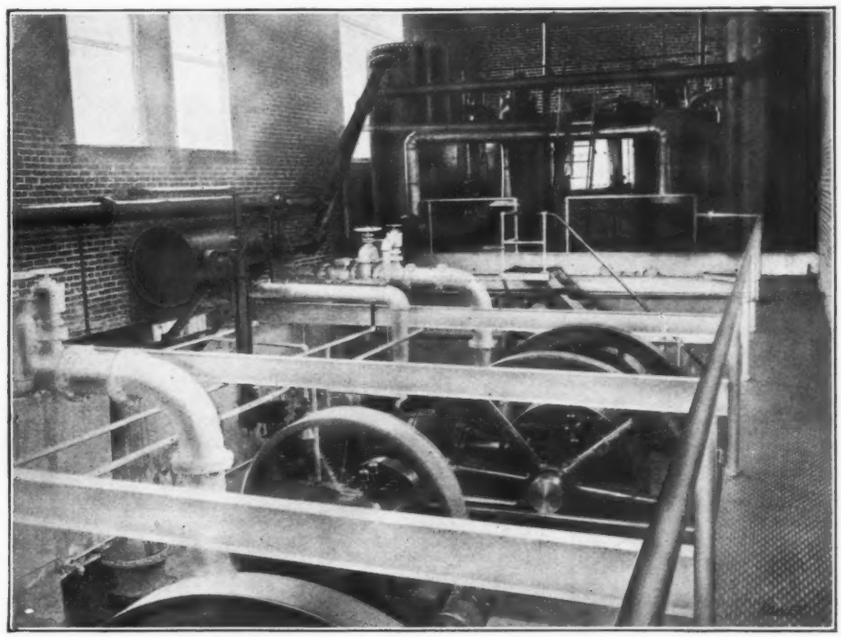


Fig. 2. Interior of Haddonfield Pumping Station

The power equipment of this station represents an innovation in small water-works construction. Instead of the usual steam boilers and uneconomical steam pumps, there are installed two complete, duplicate power units, each consisting of a triplex pump driven by an Otto gas engine and an Otto suction gas producer designed for gasifying anthracite coal. The gas generator is of the simple up-draft type with a vaporizer built in the top. The gas passes from the generator to a wet scrubber of the usual tower type. Fig. 3 shows the arrangement of the equipment.

Fig. 4 is a picture of the producers in which may be seen the charging platform, which is on a level with the tops of the generators and is reached from the producer floor by means of an iron stairway. This platform is of steel and is built entirely around the tops of both generators, giving access to them from all points. The platform extends to a door in the side of the building which opens on to the bridge leading to the coal shed, 20 feet away and on the same level. The capacity of the bin covered by this shed is 50 tons of coal. The floor of the bin is of concrete and the front and sides are of heavy timber. The rear wall of the bin is formed by a heavy reinforced-concrete retaining wall, 30 feet long by 7 feet 6 inches high, designed chiefly for the purpose of holding back the embankment, and beneath the front wall of the bin is another heavy concrete retaining wall.

The floor of the machinery pit was put at a low level in order that the suction lift of the pumps would not be excessive, even with the water level in the cistern drawn down by pumping. Each

pumping unit is composed of an 85-horsepower single-acting engine and a Deane triplex pump. Fig. 5 shows a view from the engine side of one of the units and Fig. 6 shows a view from the pump side. The engines are the standard heavy-duty single-cylinder machines built by the Otto Gas Engine Works and are direct-connected by friction clutches to the driving shafts of the pumps, to which are geared the pump crank shafts, as usual. The pumps are of the vertical single-acting type and each has capacity of one and a quarter million gallons in 24 hours against a head of 250 feet (108 pounds per square inch). The total capacity of the station is, therefore, 2,500,000 gallons per 24 hours.

On the basis of the figures just given, the water horsepower delivered by each pump is 54.3 and, with the ample allowance of 25 per cent. for friction in the pump and gears, the brake horsepower required from the engine is 72. This is only 85 per cent. of the rated power of each engine and as each of them has an overload capacity of more than 20 per cent. above its rating, the water pressure could be temporarily increased in case of fire to more than 150 pounds per square inch. This policy of operating a municipal pumping plant at moderate load and pressure, with a possibility of considerable increase in emergencies, is most excellent. It increases the life of the plant and insures its reliability, if well built.

The only auxiliaries required are a 2-horsepower Otto vertical gasolene engine, a compressor, a centrifugal blower and a drainage pump for the machinery pit. The compressor, together with a storage tank, is used to provide compressed air for starting the main engines. The blower provides a forced draft to brighten up the producer fires in the morning or after

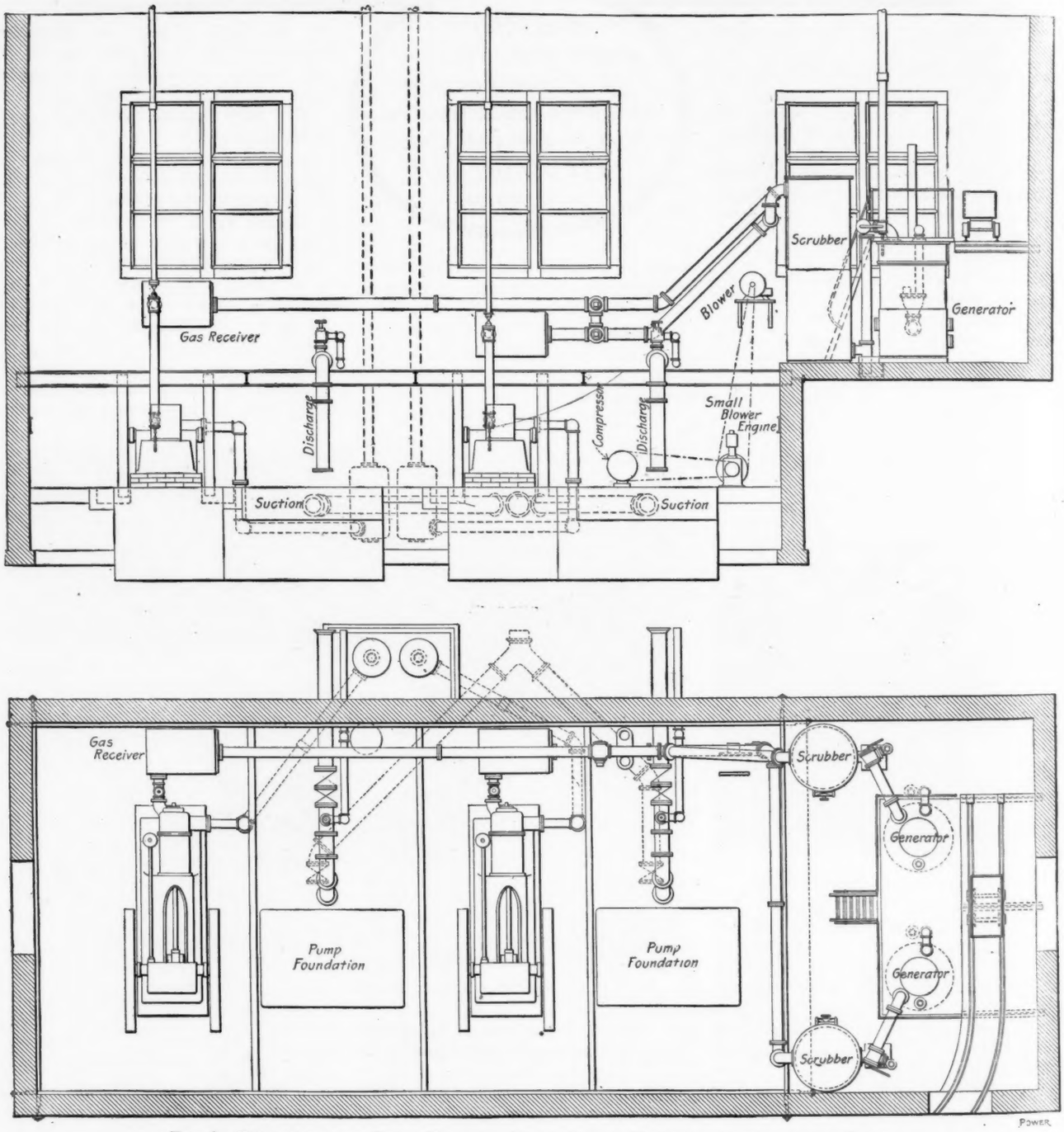


FIG. 3. ELEVATION AND PLAN VIEW OF APPARATUS IN HADDONFIELD GAS-POWER PLANT

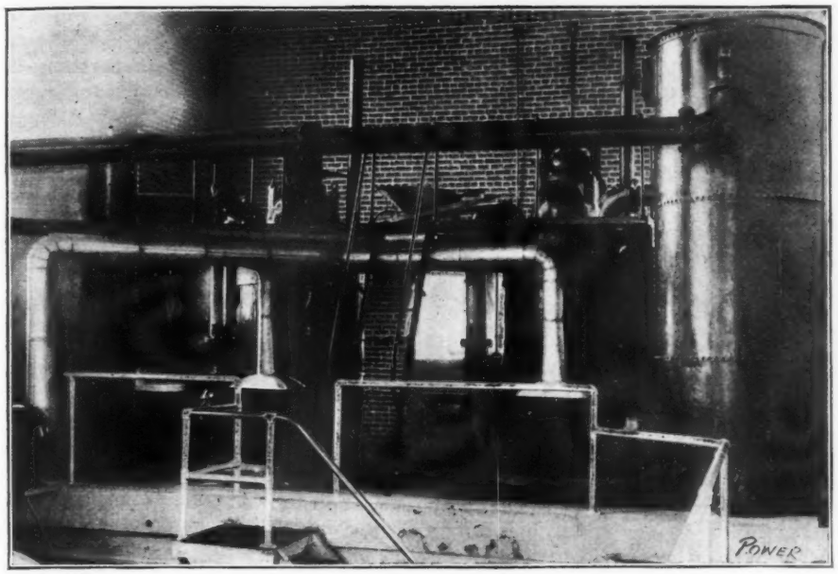


FIG. 4. THE PRODUCER EQUIPMENT

a shutdown of several hours' duration. The compressor, blower and pump are all driven by the gasolene engine.

The suction pipes are laid beneath the floor in concrete channels which are covered by steel floor plates and the piping is so arranged and equipped with valves that either engine may be operated from either producer. A neat gage board, located on the east wall of the machinery pit, is in full view from both engines. Upon this board are mounted two sets of suction and discharge gages and a recording gage which indicates high and low water in the standpipe by means of an electric alarm and registers upon a paper disk the water pressure as it varies from hour to hour.

The operating engineer of the plant has installed an excellent system for removing the dust arising during the operation of stoking the fire at the grate level. As indicated in Fig. 3, a system of galvanized pipe extends from a suction fan to the fire doors of each generator, with a hood or extension over each door. Whenever clinkers are drawn out of the fire, which is requisite only at intervals of several hours, the suction fan is started and draws all dirt away and discharges it outside the building. By this means the producer room is kept perfectly clean and no dust is ever carried over to the engines and pumps.

The supply of lubricating oil is kept in iron tanks with pipe connections leading outside to permit their being filled readily and without making any mess in the station.

As to the operation of the plant, the pumping units and gas producers are in complete duplicate; therefore, either set can be operated independently of the other or both may be operated at the same time. When the engines are not in operation, the fires in the generators are usually banked. While in this state, very little attention or coal is required for days at a time, but the plant can be placed in full operation on short notice.

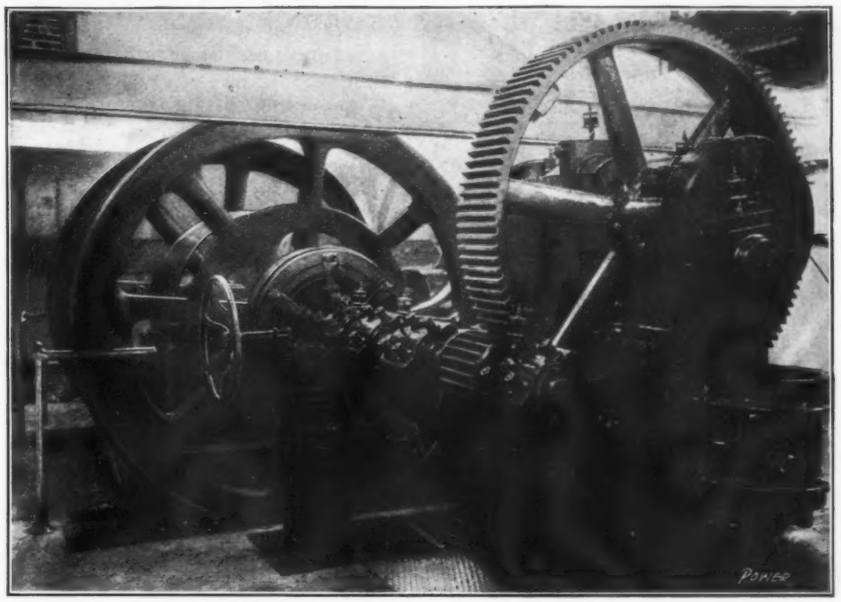


FIG. 6. ONE OF THE PUMPS AND ITS CLUTCH GEAR

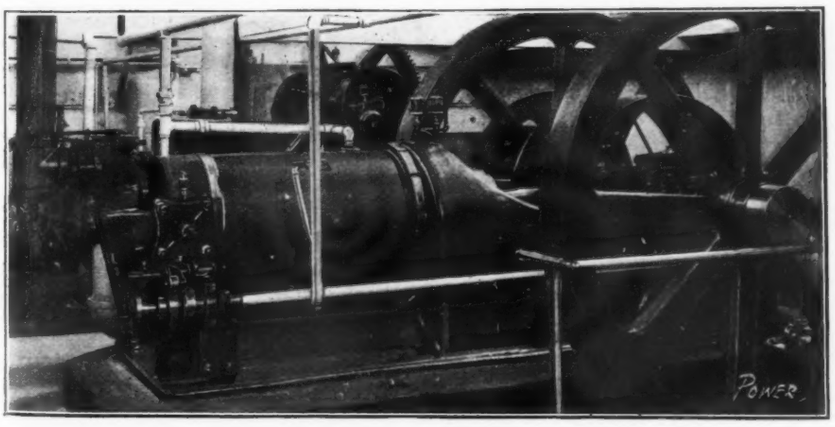


FIG. 5. ONE OF THE ENGINES

By actual experience it has been found that after a shutdown of seventy-two hours the engines could be started and water pumped within fifteen minutes. This is less time than would be required to get up steam from banked fires in ordinary boilers.

The accompanying table shows the cost of pumping 1000 gallons of water by producer gas as compared with the cost of pumping by steam. In making the comparison, data from steam pumping plants of similar size have been utilized to determine the cost of operation. The actual prices bid for a steam plant were used in determining the charges for interest, depreciation, sinking fund, etc. It should be understood, however, that the figures given do not

represent the cost of operating the whole system because, with the exception of the building and contents, no charges are made for interest, maintenance, depreciation and sinking fund for the general system. Office expenses, improvements, etc., are likewise not included, as these charges would remain the same with either gas or steam as the source of power. The cost of constructing the gas-power plant as compared with a steam plant of similar size, however, has been taken into consideration.

TABLE SHOWING COMPARATIVE COST OF PUMPING WATER BY STEAM AND PRODUCER GAS

Rate of pumping is 1,000,000 gallons per day.

	Steam Plant	Producer Gas Plant
Interest on cost of building and contents for one day, rate 4½%	$2.20	$2.85
Daily average charge for repairs and maintenance	0.35	0 41
Daily debit to sinking fund, interest at 4%, based on complete renewal in forty years.	0.48	0.68
Daily cost of operation:		
(a) Labor: two men, 12 hours each, at $80 and $75 per month	5.10	5.10
(b) Fuel at $3.50 per ton	9.45	2.13
(c) Oil	0.20	0.25
(d) Waste	0.02	0.02
(e) Light (oil)	0.10	0.10
(f) Miscellaneous	0.20	0.20
Total daily expense	$18.10	$11.74
Estimated cost of pumping 1000 gallons water by steam		1.81 cents
Estimated cost of pumping 1000 gallons water by gas		1.17 cents
Estimated saving per 1,000,000 gallons water pumped		$6.36

Producer Gas from Crude Oil*

By E. C. Jones

The production of gas from crude petroleum or its products is not sufficiently standardized to give figures necessary to exactly determine its economy. California with its immense deposits of petroleum is the natural and logical field for the exploitation and industrial use of oil producer gas. It is to be deplored that such an important subject was first considered by men not conversant with the manufacture of oil gas, who, in casting about for apparatus to make producer gas from oil, naturally gravitated to the old familiar methods of retorting the oil; any improvements that grew out of these methods seem to have retained the objectionable features of the retort system. Briefly stated, these features consist of the necessary shutdowns for the purpose of removing coke and frequently for burning out accumulated soot and lampblack. A typical analysis of gas made in this way is as follows:

CO_2	4.6	CH_4	12.6
CO	7.4	H_2	3.1
O_2	0.4	N_2	71.9

British thermal units per cubic foot, 172. Claimed thermal efficiency, 39 to 62 per cent. Operating thermal efficiency, 55 per cent.

*A paper presented at the San Francisco meeting of the American Society of Mechanical Engineers.

This gas has been applied to the operation of small gas-engine units up to and including 100 horsepower. Owing to the abundance of petroleum in California, it has superseded all crude material in the manufacture of illuminating gas.

The first oil gas manufactured on a large scale in California has the following analysis:

Heavy hydrocarbons	6.2
Marsh gas	26.6
Hydrogen	62.4
Carbon monoxide	3.0
Carbon dioxide	0.2
Oxygen	0.4
Residual nitrogen	2.2
	100.0
Specific gravity	0.303

By improvements in apparatus and refinements of operation the hydrogen content of the gas has been reduced to less than 40 per cent.; the marsh gas has been increased to 34 per cent.; the carbon monoxide has been increased to 9 per cent.; the specific gravity to 0.485, and the heat value from 624 to 680 B.t.u. per cubic foot. The oil gas generators used at present for manufacturing illuminating gas are so elastic in their operation that any of them can be immediately adapted to the manufacture of producer gas from oil, the chemical composition of the gas and its value depending only upon the manipulation of the generator.

The writer has carried on a series of experiments with oil producer gas, using a large generating unit, and the only change in equipment was the use of compressed air at from 35 to 40 pounds pressure for the injection of oil and to assist in the partial combustion of the oil. During these experiments producer gas was made having a thermal value as low as 103 B.t.u. per cubic foot and as high as 482 B.t.u. per cubic foot. Unfortunately no ready means was at hand for measuring the quantity of gas made and the amount of oil used to produce 1000 cubic feet. A typical analysis of this gas is as follows:

Carbon dioxide	4%
Heavy hydrocarbons	2 or less
Oxygen	1
Carbon monoxide	5
Hydrogen	5
Marsh gas	13
Nitrogen	70

This gas has a calorific value of 160 B.t.u. per cubic foot. To use this gas successfully in gas engines it is necessary that it shall be thoroughly cleansed by efficient scrubbing, and that it shall be uniform in calorific value and chemical constituents. This last can be readily accomplished in the operation of oil-gas generators, by careful measurement of the oil used and the air supplied for its partial combustion, and the maintenance of a fairly constant temperature in the generator.

This can be done as in oil-gas manufacture by a determination of the necessary temperature by the observation of color in the checker brick and the maintenance of this temperature by frequent observations through sight cocks by the gasmaker.

Making producer gas from oil in the ordinary gas generator has many advantages over any special process. The gas can be made in very large quantities and the amount made can be easily regulated to the needs. The operation is continuous and without interruptions for cleaning. This is essential in the manufacture of producer gas for power purposes. In any other known process the interruptions are not at stated intervals but occur when the producer refuses to work, owing to the clogging up of its parts by coke or lampblack.

Oil-gas generators have no easily destructible parts, as the lining and checker brick are constructed with a view to resisting high temperatures and, although a much higher temperature is desirable in making producer gas than that employed in making oil gas in retorts, the checker brick are not seriously affected by the high temperature. In the decomposition of oil in the presence of air, there is complete disposition of all the gas-making constituents of the oil, so that producer gas can be made without a by-product of any kind. Any accumulation of carbon in the generator may be removed by adjusting the temperature and quantity of air supplied.

This method of making gas requires a small gas holder for momentary storage, and the process as at present understood could not be used as a suction gas producer. Producer gas made from oil and containing a small percentage of hydrogen possesses advantages over illuminating-oil gas inasmuch as it can be subjected to higher compression in gas-engine cylinders and, with a gas of uniform analysis, uniform piston speed can be obtained.

CORRESPONDENCE

Mr. Barker's Engine Speed

In the February 28 number, O. J. Barker asks if a speed of 300 revolutions per minute is too high for a vertical, single-acting engine of 9½ inches bore and 12 inches stroke, built with a crosshead. My opinion is that such a speed is too high for a single-acting engine. When the piston reaches the end of the expansion stroke it has no cushion against the open end to assist the sudden reversal of stress. At such a high piston speed (600 feet per minute) a sudden reversal of stress would more than likely cause a pound at the end of the downward stroke. Especially is this true in this type of engine as the power stroke is downward and the inertia of the various parts tends to increase the sudden reversal of stress.

Thomas H. Brockman.

New Orleans, La.

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words wanted

The Line Shafts Break

During the last two years there has been considerable trouble with the breaking of shafts, as nearly every shaft of any importance has broken during this time. A $2\frac{1}{16}$-inch shaft has let go three times, and three others of $2\frac{7}{16}$ inches have broken, all doing considerable damage. They all break in the hub of the driving sheave of the American system of rope drives. The sheaves are keyed to the shafts by a straight key with two set screws on top to hold the key firmly in place. The shafts are not out of line and are not overloaded. The $2\frac{1}{16}$-inch shaft drives but 50 horsepower, and the other shafts about 20 horsepower each.

The danger of maiming or killing employees is apparent. The expense of maintenance is great, as the ropes usually become tangled and the shaft comes down, taking everything with it before the power can be shut off. Good machinists have been employed for the repair jobs but the shafts keep on breaking. Can any reader of POWER suggest a probable cause or remedy?

Chicago, Ill. A. RATHMAN.

A Homemade Safety Stop

When I took charge of a certain steam plant, I recommended the installation of some kind of an automatic safety stop, so that in case of necessity the engine could be stopped by pressing a push button from various points in the factory without waiting to signal or telephone the engineer.

But as there was some delay in regard to the matter and feeling somewhat apprehensive that something might happen when none was near the engine to shut it down quickly, I came to the conclusion that I could make a safety stop, and it has proved reliable in every way. The accompanying illustrations will give a very clear idea of the construction and operation of the apparatus. The only parts that had to be purchased were the push button, batteries, wire and magnets. Any type of electric-gong magnet will answer the purpose; otherwise the rest of the material costs nothing, and the only expense is the machinist's time in making it. The method of making this safety stop is described herewith.

The brass knuckle on the end of the governor link *A*, Fig. 1, is slotted so that it can be disengaged from the stud *B*. The lever *C* is mounted upon the bell-crank bracket of the governor, and is secured by three set screws to the collar *D*, upon which it moves freely by means of the strap *E*. The link *A* passes between the grooved rollers *G*. The magnetic releasing mechanism is attached to the front of the governor column in the position indicated at *H* so that the lever *C* rests upon the trip *I*, Fig. 2. This trip is held down by the trigger arm *J*, which is secured to the top of the armature *K*, mounted between the two pivots in the top of the brass posts *L*. Upon pressing

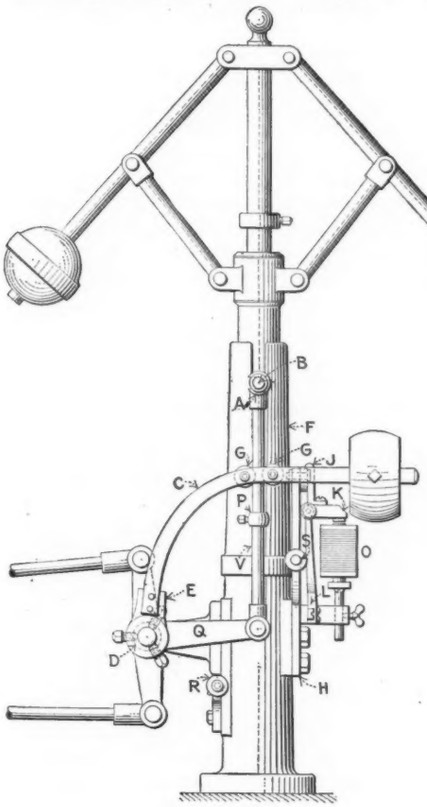


FIG. 1

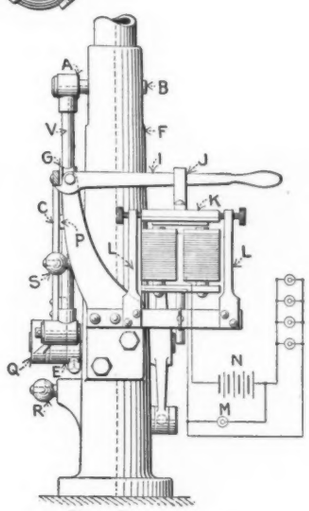


FIG. 2

DETAILS OF HOMEMADE SAFETY STOP

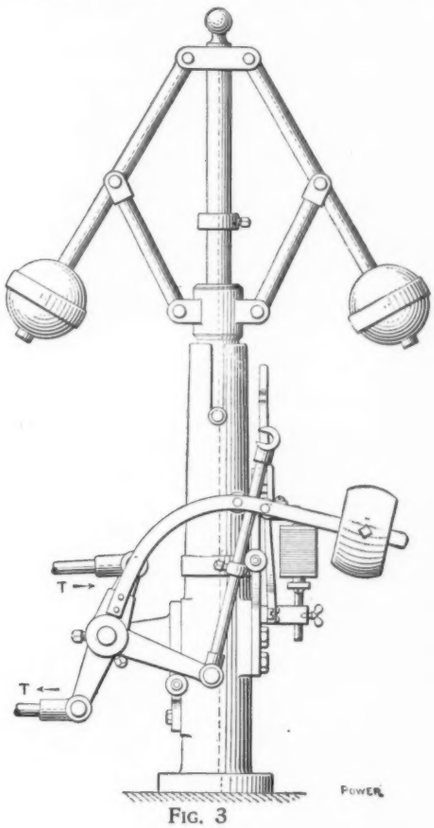


FIG. 3

any one of the push buttons *M*, the circuit is closed through the batteries *N* and magnets *O*, which pulls the armature *K* and the trigger *J* down, thus releasing the trip *I*, whereupon the lever *C* drops, and, in so doing, throws the link *A* off of the stud *B*. The lever *C* then strikes the adjustable stop *P*, thereby forcing the arm *Q* down to the rubber-cushioned stop *R* and at the same time the arm *V* comes to rest on the stop *S* and assuming the position indicated by Fig. 3. This moves the rods *T* in the direction shown by the arrows, thereby throwing the valve cam into such position that the knockoff blocks come in contact with the hooks and prevent the steam valves from opening, thus stopping the engine.

GEORGE J. LITTLE.

Passaic, N. J.

Carelessness Causes Accidents

A high-speed, center-crank engine pounded badly. The engineer, who was a new man trying to make good, had disconnected the crank-pin end of the connecting rod in order to ease away the brasses. He had then closed up the crank case and started up, but the engine began to pound and heat badly. Investigation showed that there was an accumulation of wood pulp, mixed with the oil inside of the case, and the connecting rod was also sprung, which caused the heating.

The engineer then remembered that he had used a piece of wood to block up the connecting rod while facing off his brasses and when connecting up again this block of wood had fallen down to the bottom of the crank case and he had failed to remove it. Just a little carelessness.

In another case a boiler-feed pump suddenly refused to feed enough water to the boilers. A small test gage was connected to the discharge line of the pump and upon starting the pump a higher pressure was obtained on the test gage than showed on the steam gage on the boiler, showing that there was an obstruction in the discharge, notwithstanding the pipe was new. Upon tracing up the pipe line it was found that in one out-of-the-way place the pipe went through a wall and a short piece of old pipe had been left in place, as it was difficult to get at. The new piping had been connected at each end and, as the old pipe was almost filled with scale, when the pump was started after the repair work had been finished a small piece of loose scale was forced into the small opening in the old pipe, partially closing the same and causing the trouble. Failure to tighten the lock nut securely on the dashpot rod after making adjustments allowed the nut to work loose and the rod to lengthen, resulting in a bent rod.

In the case of a Greene engine, when putting new steel plates on the tappet the engineer failed to properly tighten the screws, which worked loose and allowed the plate to drop, breaking the tappet.

These accidents were all the result of carelessness and could have been prevented.

CHARLES H. TAYLOR.

Bridgeport, Conn.

Dusty Engine Room

Can any reader tell me how I can keep dust from collecting on the walls and ceiling of my engine room. Dust is drawn in by the driving belts of three engines, each belt 20 inches wide and traveling at a speed of 3500 feet per minute. I have a hardwood floor and have it scrubbed once a week, but this dust spoils the looks of the engine room.

Has any reader any suggestions to offer as to how I can rig up a suction vacuum cleaner to remove the dust from the walls and ceilings, as sweeping it does not make a good job?

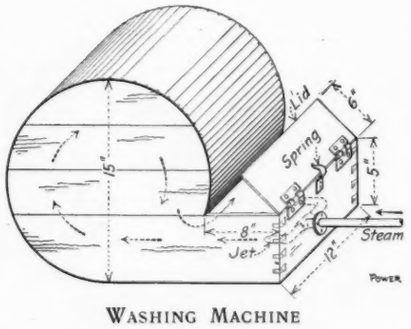
S. G. ROSE.

Brockville, Can.

Engineers' Washing Machine

Many forms of steam washing machines for washing overalls, etc., have been made by the man on the job that have given more or less satisfaction.

The washer shown in the drawing herewith uses steam only, and will wash a garment, no matter how dirty, in two minutes. The garment is soaked in soapy water and, without wringing, is placed in the washer and the steam turned on. When the garment attains a speed of



WASHING MACHINE

between 45 and 60 revolutions per minute, enough steam has been turned on. If one is particular the garment might be rinsed a little after washing.

The width of the front lid is two inches narrower than the opening. The sides of the washer, also the crosspiece through which the pipe to the jets enters, are made of 1-inch dressed lumber. A strip of galvanized sheet metal 14 inches wide and long enough to go around the bottom and circular sides of the machine is nailed to the edges of the wooden sides and crosspiece. The cover is made of the same material and is fastened by hinges to the crosspiece.

When the garment has been placed in the machine and the steam turned on, the garment follows a path shown by the arrows. The steam follows a circular path the same as the garment, but escapes through the opening in the front while the garment drops directly in the path of the jet of steam from the nozzles and is driven around again.

It is not necessary to construct the machine water-tight.

LOUIS T. WATRY.

Pueblo, Colo.

Isolated Plant Engineering

The central station versus the isolated plant has become a very serious question for the consideration of the engineer who operates the latter plant. Engineers have been urged to keep records of the daily performances of their plants in such a way that they may be thoroughly understood by their employers and used to refute the very clever and persuasive statements made by the central-station solicitor.

This is all very well, but I would like to ask how the average engineer is to procure all these data? Suppose, for example, that an engineer is put in charge of a building where there is a heating and lighting plant and, as is generally the case, is under the supervision of a superintendent. The engineer carefully looks the place over for a while, taking note of the methods of the operating force, the kinds of fuel burned, lubricants used, when the boilers are cleaned and, in fact, makes a general survey of the plant and its operation. Discoveries are made and noted and the engineer decides upon some changes which in his best judgment will be to the benefit of the plant. Having the data in regard to this particular change he wishes to make, he goes to the superintendent and with all the confidence of a man who thoroughly understands his subject presents his plan.

It may be he will get recognition and he may get the necessary material to make the change, but in 99 out of 100 cases he will be turned down and gently but firmly sat upon.

Worse than this, at a later date an outside mechanic will appear with material and men to do the same job that the engineer suggested and he is told that the idea came from headquarters. Such methods are not conducive to a proper feeling on the part of the engineer, but yet such an occurrence is not an impossible or imaginary situation.

Another phase of this question which has always attracted my attention is the apparent lack of confidence of the employer in the engineer. I know of good engineers who were put in charge of plants and were not even given the au-

thority over their own force, and yet they were paid a good salary and were well thought of.

How is a man to make known his ability, beyond the more or less successful operation of his plant with what the employer chooses to give him, unless he is consulted and given an opportunity to show what he can do? Some may say, let him take his ability where he can get full value for it, but that is much easier said than done.

Regarding engineers preparing themselves for the demands made upon their ability, I think that if employers would give the engineers a chance to show whether they are worthy of the name and can operate more cheaply than the central station can supply electricity, it would be a simple matter to answer the question when the time comes. It would seem to be more of a question of coöperation between employer and engineer than one of whether the engineer can beat the central station. The engineer alone cannot beat the central station, so let the employer get busy as well as his engineer.

WILLIAM N. WING.

Brooklyn, N. Y.

Low Charge of Electrical Energy

When the first bonds were to be voted for the municipal plant at Pasadena, Cal., the Edison company, backed by $20,000,000 of capital and owning the electric-light plants in thirty-five cities, would not give out any information to the citizens of Pasadena as to the cost of producing electrical energy or what a profitable selling price would be. As a result, the city built its own plant which contains the very best of machinery, has been enlarged three times in four years and has made good.

The plant now furnishes electrical energy to 3650 private consumers and takes care of all the public and street lighting. There is a sliding scale of from 5 cents down to as low as 3 cents per kilowatt-hour for larger quantities of energy used for lighting purposes; for power the rate runs from 4 to 5 cents per kilowatt-hour. The plant with the distributing system reaching into every part of the city cost $450,000 in round numbers.

During the fiscal year ending June 30, 1910, the city plant paid out of its earnings the principal and interest on the bonded indebtedness incurred for its construction, in addition to all operating expenses, and had left for depreciation and new construction an amount equal to approximately 5 per cent. of the cost of the plant.

I am informed that it cost the Southern California Edison Company $0.0216 per kilowatt-hour to furnish electricity in the city of Los Angeles during the year 1909. During the same period the Pasadena municipal lighting plant produced electrical energy at an average cost of $0.020 per kilowatt-hour. The residents of Pasadena remember when they paid at the rate of 15 cents per kilowatt-hour for lighting their houses, and now the city plant furnishes them with light at a base rate of 5 cents per kilowatt-hour.

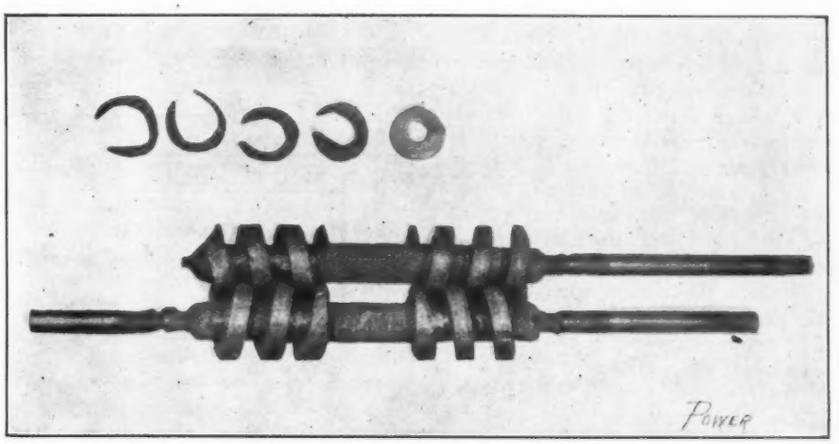
From the standpoint of the city as a whole, it may said that its people have, and are now, effecting a saving of not less than $100,000 per annum by reason of the difference in rates charged before the city built its plant and the rates which are now in effect.

W. M. GLASS.

Pasadena, Cal.

Worn Pump Worms

Readers of POWER may be interested in the long service that has been obtained from a screw pump. Nine years ago two screw pumps were installed in a 14-story office building to pump the water for four hydraulic elevators. The accompanying illustration shows the screws or worms which have been in continuous operation in No. 2 pump for eight years, operating ten hours a day, six days a week. In that time the pump has been idle about two months, due to motor repairs. The illustration shows the shafts worn more than half way through and one end entirely worn off by the action of the water, thrust washers and packing. The pump was operated for six weeks after the missing end of the shaft had broken off, the screw guiding itself in the cylinder.



WORN PUMP WORMS

The four horseshoe-shaped rings at the left show all that is left of the illustration of the thrust washers; the tap ring shows how a new thrust washer looks.

After the screws were removed, the cylinders were measured and showed but 1/64 inch more than their original diameter, and this was at the end of the end where the loose screw with the broken shaft revolved.

The screws were 7 inches in diameter; the pump has an 8-inch suction and a 7-inch discharge pipe and is supposed to pump about 700 gallons of water per minute at 800 revolutions per minute.

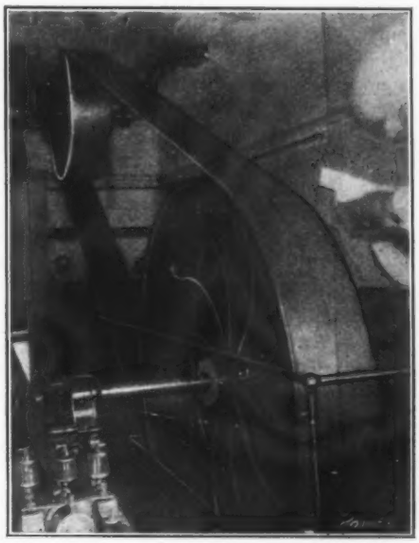
L. M. JOHNSON.

Glenfield, Penn.

An Old Belt

Some time ago I read of a belt that had been run for 25 years.

At the plant where I am engineer, there is a 20-inch belt running 2827 feet per minute that has been in service 10 hours each working day for 45 years. It is a double belt and is shown in the illustration. The engine is a Putnam and runs at a speed of 90 revolutions per minute.



SHOWING PRESERVED CONDITION OF BELT

CHARLES E. HARRIMAN.

Concord, N. H.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Operating Cost of a Small Water Works

Having read the editorial, "Publicity of Operating Costs" in the issue of March 7, I will do the best I can to give the readers of POWER the actual running costs of the station of which I am in charge.

This is a small town of about 6000 inhabitants. It has a direct-pressure system with a standpipe located at the highest point in the village. We pump from a receiving basin fed by gravity from springs. The average suction lift is 20 feet and the discharge head averages 160 feet.

The pumping station contains two horizontal return tubular boilers, 60 inches by 16 feet. These are used alternately and are in fairly good condition considering their age which is 24 years. They were operated for 13 years at their full capacity for during that length of time electric current was generated for use in the town. They are of the lap-seam design and since reading the recent articles and editorials in POWER I am sure that they have seen their best days although they are given a pretty good standing and are allowed 85 pounds pressure by one of the leading boiler insurance companies.

The pumps are Worthington direct acting, one is a compound 12 and 18½ by 10¼ by 10 inches in size and the other is a simple 16 and 10¼ by 10 inches (this one is held in reserve for emergencies). There is one boiler-feed pump 5¼ and 3½ by 5 inches, delivering water through a Baragwanath heater to the boilers at a temperature of 210 degrees.

We operate, on an average, 10 hours out of the 24 and, being subject to a fire call at any time, have steam up with banked fires between. The night engineer reads the service meters monthly. We use run-of-mine coal which costs $2.95 per ton delivered in the coal bin.

The cost of operating the station for the year ending Feb. 28, 1911, was as follows (Not including interest and depreciation):

310 tons coal @ $2.95	$914.50
Oil and waste	11.50
Packing	13.25
Repairs	43.50
Engineer and assistant	1083.50
	$2066.25

In the year we delivered to the mains 86,836,900 gallons of water against an average total head of 180 feet using 310 tons of coal. This shows the duty of the plant to be slightly over 21,000,000 foot-pounds of work per 100 pounds of coal. The cost of pumping was, then, 2.379 cents per 1000 gallons delivered.

The water end of the pump shows an efficiency of 90 per cent. and I think it will be of interest to some to hear how I find this as we have no meter on the delivery line.

When the receiving basin, which is 27 feet in diameter, is pumped down and we are not running I note the level of the water and the time. Taking the level again one hour after, it is easy to calculate the number of gallons running in per hour. On starting up I note the counter reading of the pump, the time and the water level in the basin, taking them again after the pump has run one hour.

The efficiency is then found by dividing the water actually delivered (which is the amount which runs into the basin plus the amount taken out by lowering the level) by the displacement of the plungers of the pump.

These figures are not given as models of economy but as actual running expenses of a small old-fashioned pumping plant and I should very much like to see them compared with those of a modern uptodate plant of about the same size running under similar conditions.

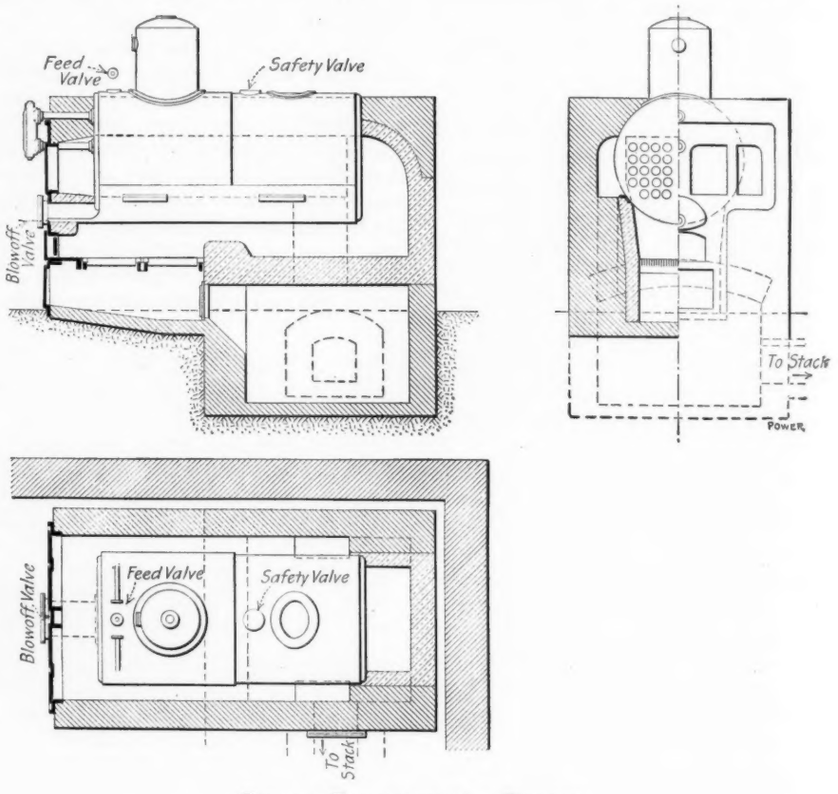
S. SCARTH.

Newark, N. Y.

Boiler Setting

Some time ago there appeared in POWER a very complete paper by S. F. Jeter on "Setting Horizontal Tubular Boilers," which I have read with a good deal of interest.

Herewith is a design of a horizontal tubular boiler setting which is used very extensively in this country with satisfactory results. The bottom sheet of the boiler is in one piece; thus there are no seams with rivets exposed to the action



RETURN TUBULAR-BOILER SETTING

of fire on the outside and mud (sediment) on the inside of the plate. The cover of the cleaning nozzle (the nozzle is connected to the lower front part of the boiler) can be taken off and the sediment scraped and washed out. A lamp can be brought into the boiler through this opening and nearly the whole of the bottom sheet and the bottom part of the lower row of tubes can be inspected. The boiler is set with an inclination toward the front; the blowoff valve is placed on the cleanout cover, oftentimes the feed valve too.

JOHN ZEUERLUND.

Eskilstuna, Sweden.

Belt versus Electric Transmission

In the March 21 issue, Franklin Van Winkle takes exception to my article in the February 14 issue on central-station versus factory-plant service, making the statement that the friction in many hundreds of plants has been found nearer 10 than 20 per cent. of the total power required.

This does not agree with the results of tests of many of the plants that we have investigated, nor the results that are reported in many of the papers and which are mentioned in connection with the shafting losses in a number of handbooks. In many factories the friction loss amounts to considerably over 60 per cent. of the total power generated at the engine and these plants are pretty fairly operated. There are, of course, many textile mills and many mills in which the shafting is laid out accurately and carefully and in which recent additions have not been made to disturb the operating conditions, where the shafting losses are very small, but such conditions do not hold for any considerable length of time, nor are such conditions possible except through excessive waste of space in belt- or power-transmission towers or wells.

It is interesting to study what the actual losses are in a plant using belt drive, starting with a pretty small loss from shaft to shaft and from floor to floor until the engine is reached. Suppose, for instance, it is assumed that on the top floor of a four-story factory 20 horsepower is required, divided between four lines of shafting. On the next floor assume the same conditions and requirements and so on down to the lowest floor, where the main jack shaft is situated. This is an arrangement very frequently found. If 5 per cent. loss from shaft to shaft is allowed, the losses are cumulative and the power required at the engine is to a very considerable extent larger than would ordinarily be required if the shafts were driven direct from the engine. The following table shows to what extent this cumulative friction increases and it will be noted that 5 per cent. is used as the average loss of power for each transmission belt; this is by no means a figure accomplished under average conditions.

Top floor, 20 horsepower; 4 shafts, 5 horsepower each; 5 per cent. loss between shafts.

	Horsepower.
Power required at the main shaft on 3d floor for top floor	22.06
Power required, 2d floor for 3d floor	45.22
Power required, 1st floor for 2d floor	69.54
Power required to operate 1st, 2d and 3d floors from engine	97.33
Total power required at shafting	80.00
Loss	17.33

or 21.7 per cent., which is quite different from the loss that would exist with individual drives to each shaft. It should be noted also that this loss is to a considerable extent represented by slip, so that the speed of the shafting is continually dropping from what would be expected on pulley ratios, materially influencing the production factor of the machinery. As vertical drives are of frequent occurrence in a factory of this character, figures of 5 per cent. loss on an average between shafts is considerably below that met with in practice, although it is not below what could be accomplished by proper arrangement in many cases.

In machine shops the conditions are radically different and so are they in many types of plant where the machinery is not constantly in operation so that the power lost in driving the shafting may be, and frequently is, a very heavy item of expense. Under such conditions the power required to operate with belt drive would be much larger than that required to operate with electric drive. Each plant has its individual characteristics, and it is necessary to make a careful study of each plant to determine what is the proper type of drive. It not infrequently happens that with a plant already installed, a rearrangement of belting is much cheaper than the installation of electric drive, and that a belt-driven plant can be operated more cheaply than electrically driven, either by power purchased or power generated in the plant itself.

When motor drives are installed, they should be installed with a thorough knowledge of the influencing conditions so that the motors will be adapted to the purpose in hand and every precaution should be taken to reduce the friction losses to the minimum. The efficiency of the motors is an important consideration, also the efficiency of the drives connecting the motors to the shafting. It frequently happens that unless the engineer installing the drives is thoroughly conversant with the motors and the machinery to be operated, very much larger motors are installed than are necessary. It also happens that in order to save first cost, the owner and engineer install motors which are of far too high a speed to operate satisfactorily or install the motors on too short centers with too large ratio of driver to driven pulley. All of these things militate strongly against the success of the electric drive. On the other hand, similar mistakes work against the belt drive; there is just as much danger of a poor layout in a belt-driven plant as there is in an electrically driven plant and there are quite as many belt drives throughout the country which are failures, if their owners and engineers but knew it, as there are electric drives.

Mr. Van Winkle's statement that he was called in to consider a case where the proprietor of a plant was greatly disappointed is exactly in line with conditions which are frequently met. The electric motors in this case were probably not installed properly and the central-station salesman was probably thoroughly onto his job as a salesman and very far from onto his job as an engineer. The factory owner who bites at the salesman's figures of operating cost in his plant as driven by belts and at the economies which are likely to accrue from the installation of electric motors and makes no further investigation, usually gets stuck and there is every reason why he should expect to get stuck. This same factory owner would not allow the agent for some company supplying him with materials to estimate what it would cost him to get materials from half a dozen of his competitors but he would actually get competitive prices. Why, then, should not this man take the same precaution when it comes to the matter of power? If he is not capable of making up his own figures as to what power costs him, why should he take the figures of the central station and buy material of which he knows nothing?

The electric drive has many advantages over the belt drive. So, too, has it many disadvantages unless properly installed. Mr. Van Winkle leaves out one item in his tabulation of advantages, which is of very considerable importance, that is, uniformity of speed, resulting in a considerable increase in production. This production factor alone, if properly looked into, is, in many cases, a sufficient cause for the introduction of the electric motor and, further, is very often a sufficient explanation for a considerable increase in the cost of power. In a number of cotton mills in the South where electric drive is installed, under the first year's operation the factory owners were very much disappointed to find that the total cost of power during the year was considerably greater than the cost of power during preceding years. Their engineer, however, was far-sighted enough to go a little bit into the figures for output during those years, with the result that he discovered that the total cost per unit of goods manufactured was less than in previous years.

While I am strongly in favor of the electric drive where it is suited to conditions, I am not a believer in electric

drives under all conditions. I believe that there are places, and a large number of them, where the belt or rope drive is more economical than the electric drive. I believe that there are places, and many of them, where it is cheaper for the factory owner to purchase power than to generate it. I believe, too, that there are places, and many of them, where the factory owner can generate his own power and use it through electric motors more cheaply than he can either buy it or operate by belt drive. Every plant must stand on its own merits and no factory owner can say because "John Jones operates his plant more cheaply by belt drive than Tom Smith does his by electric drive, I can put in belt drive and operate more cheaply than I can by electric drive."

HENRY D. JACKSON.

Boston, Mass.

The Giddings Engine Valve

Allen J. Stocks illustrates an engine valve in the issue of March 28 and asks if anyone ever saw anything like it. This is the well known Giddings valve and was used very successfully for many years by several engine-building concerns prominent in the manufacture of high-speed engines.

Fig. 1 shows a section of the valve and valve face. It will be observed that the valve takes the form of the Allen valve with the difference, however, that the steam enters the middle of the valve through the port *S*. With this arrangement there would be a tendency to throw the valve from its seat unless it were

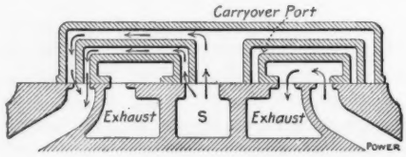


FIG. 1. SECTION THROUGH GIDDINGS VALVE

counterbalanced by a pressure on the back of the valve. This pressure was secured by means of a needle-hole port from the steam inlet of the valve. In order to keep the pressure within certain limits, there was a needle-hole port of slightly larger area communicating with the exhaust chamber of the valve. It usually took about 45 per cent. of the boiler pressure to keep the valve from slapping on its seat.

One remarkable feature of this valve was the supplementary passage or carryover port which increased the volume into which the steam was compressed without increasing the clearance space from which the steam was exhausted as this port was never in communication with the exhaust.

Fig. 2 shows a pair of indicator diagrams from an engine with this type of valve. The compression curve starts to rise when the edge of the valve covers the exhaust port and it continues to rise until communication with the supplementary port is established, increasing the volume into which the steam is compressed and enlarging the area of the diagram over that shown by the dotted lines.

The engines built at the time when this valve was used were of comparatively long stroke, the sizes ranging as follows: 6x10 inches, 8x12 inches, 10 x16 inches, 12x18 inches, 14x20 inches, etc. As single-valve engines they were hard to beat in the matter of economy. The large sizes could be run on 30 pounds of steam per indicated horse-

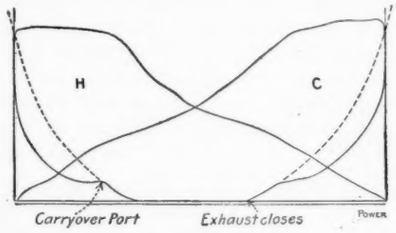


FIG. 2. DIAGRAMS FROM ENGINE WITH GIDDINGS VALVE

power with a pressure of 100 pounds at throttle, noncondensing. They were much more economical than the high-speed engines at that time with the so called piston valves (which were simply a plug in a hole) which leaked scandalously, or the many forms of flat valve balanced by a pressure plate.

CHARLES A. CAHILL.

Milwaukee, Wis.

In POWER for March 28 Allen J. Stocks has a letter, some diagrams and a cut of an engine valve about which he seems to be puzzled. I operated a Russell engine for three years that was fitted with this valve. The valve is balanced; there are two needle-hole ports in the top of the valve, one that admits steam from the face to the back of it and the other, which is a little larger, forms a communication between the back of the valve and the exhaust of the engine. These small ports retain enough steam back of the valve when the engine is running to balance the valve and keep it on its seat.

By means of an angle valve in a ¼-inch pipe, steam may be admitted from above the trottle to the back of the valve when starting and stopping the engine, this keeps the valve from slamming on its seat.

The valve takes and exhausts steam at its face. I cleaned the burned oil from the back of the valve and found fine lines to correspond with the edges of the ports on the face of the valve by which the valve could be set.

If Mr. Stock's engine is a Russell he will find that there is an adjusting nut where the rod connects with the eccentric and that the length of the rod can be changed either way.

The diagrams show all events of the valve to be early, also the valve to be one sided, although not very much so.

The engine mentioned had a Giddings governor which is quite complicated and if taken apart is liable to be put together wrong, which might leave the valve setting off.

This may be the trouble in Mr. Stocks' case as a long rod would make the events early on one side and late on the other.

JAMES W. BLAKE.

New York City.

The Position "Higher Up"

In the issue of March 21 there are two articles under the above heading. The one by L. F. Wilson is right to the point and contains some very good advice.

I wish to call special attention to what Mr. Wilson says about "blind advertising." Only a few weeks ago I ran a blind advertisement for a position and I got two answers. One came from Philadelphia and one from Boston. The one from Boston asked me to "call around" and see a certain party! Perhaps I might have secured a good position, but it is not an easy matter for me in New Orleans to call around in Boston!

The other letter in the March 21 issue, written by Edward Adams, tells how the writer stepped out of the fire room into his first job as chief. All this may be interesting but it is of little value to the man trying for the position "higher up" unless he is in the same fire room that Mr. Adams left. But his first paragraph hits the nail on the head.

In the first-page editorial of POWER for March 21 there is more horse-sense concerning this matter than can be found on any other page of POWER. It says "Pick out your goal, keep your eye on it and work to get there." Everyone who expects to better his position should read this article over and over, and study it.

He who says "There ain't no chance these days for a fellow to get along" will never get any higher. Turn to the first-page editorial of the March 28 issue and read that carefully. Do you fully grasp its meaning? No, not at a first reading. This editorial too should be studied. Do you realize that "there are more opportunities than ever going a begging for lack of men to see and make use of them?" But why this lack of men? "These are wonderful times," times of progress, and a fellow must keep up with this progress. He cannot "wish" himself into the position "higher up," he must go after it.

This matter of securing the position "higher up" is getting so important that it has given rise to all these articles and if a fellow cannot find a helping hand if he makes any effort to "get there," it will certainly not be the fault of the writer of those editorials on the first page.

J. E. POCHÉ.

New Orleans, La.

In a recent issue, Oscar J. Richmond suggested that ideas be given upon the subject of how to proceed to secure a better position, assuming that one is properly qualified for it.

One's early training should prepare him to speak and write intelligently of the things he knows and to be at his ease among the cultured. When he endeavors to secure a higher position he needs to be able to show his prospective employer just why it will be advantageous to secure his services, just as the salesman must show the buyer why it will be to his advantage to buy the particular article that the salesman is offering. General, coupled with technical, education is necessary for this, and the more education an engineer can obtain the better it will be for him.

At all times one should take pains to work up as wide a reputation as possible of being a high-grade man so that when a man is needed for a desirable position in the neighborhood, he will be among the first to be thought of. One should be a mixer both in the associations of his fellow craftsmen and in a general social way. He should, as far as possible, cultivate the acquaintance of employers, and in this his personal appearance will count greatly. He should dress as well as the circumstances and his means will permit and remember that he may lose much more in opportunities for advancement by going poorly dressed than he saves in clothes. The commonly accepted badges of his profession, dirty hands, overalls, etc., should be discarded whenever his duties will permit, while at work he should be as neat personally as possible. The better class of employer takes note of such things and prefers employees that make a creditable showing, both on duty and about the streets and other public places.

One should avoid talking shop and should avoid appearing big-headed but, on the other hand, should make use of his opportunities of showing that he knows his business and knows it well. He should not claim to know it all, but he should let his conversation and actions show that he does know a great deal. Whenever occasion offers he should help his fellow craftsman and not be afraid that the ideas he thus gives away will help another to get the position he himself desires. If one has the reputation of being a high-grade man among his fellow craftsmen, employers are sure to learn of it and it will be greatly to his benefit. Taking part in discussions in association meetings and writing for the technical journals will assist in working up the desired favorable reputation and will give one greater confidence in his own ability.

It often happens that one is so isolated by the place and conditions of his occupation that the foregoing suggestions are of little help and in such cases the following will more particularly apply.

In many sections of the country there are employment agencies that make a specialty of technical and professional positions and if such an agency is available it will often prove the easiest and best means of securing the desired result. Employers frequently advertise for high-grade men and advertisements for help in the desired line should be watched for and replied to. Replies should be made promptly and whenever possible in person. Take a day off and spend a little money for railroad fare if necessary. The trip will do you good and, though you may be too late to secure the position, it will extend your acquaintance both among employers and members of your own craft, and if a good impression is left with the employer he may call on you when next in need of a man, or recommend you to another. Great pains should be taken to leave a good impression. The clothes should be good but not showy, and the manner natural. No attempt should be made to show off. All questions should be answered carefully and truthfully. If a question be asked about some subject one does not understand he should be frank and admit it. Attempting to conceal is usually the surest way to get into trouble. Besides, no one is expected to know everything and have it all on his tongue's end. The employer should be allowed to do most of the talking. He knows the points he wishes to bring out. Many applicants make the mistake of trying to teach the employer, imagining that they are displaying their knowledge to advantage. The writer once heard an employer tell an applicant that he was looking for someone to do his work and not to teach others how it should be done.

When advertisements cannot be answered in person it is often wise to telephone or to telegraph. Telephoning is best where feasible as it gives the employer opportunity to learn more of the applicant. Lastly, the advertisement may be answered by letter. The letter should be carefully worded and carefully written. As much information as possible that bears directly on the suitableness of the applicant for the position should be given and copies of letters of recommendation should be inclosed. The original letters of recommendation should not be sent as they may be called for if desired and the employer may wish to file the letters with the application. References should also be given, as an indorsement that has not passed through the hands of the applicant is often desired and is of more value. Willingness to give references also shows greater confidence in one's own ability. Every effort should be made to make it easy for the employer to decide at once and to let the applicant know of his decision. Advertisements for help usually secure many replies and the ones that contain the information that the employer desires receive his attention first.

Advertising for a position is often the first means resorted to. The first thing to be considered is the medium to be employed. Care should be exercised to use mediums that reach the greatest number of the class of employers desired. Often, one's own journals are not read to any great extent by the employers he wishes to reach. A manufacturer may employ a number of steam engineers and yet seldom look into a steam-engineering journal. Often, several mediums circulating among different classes should be used.

The proper medium or mediums having been selected, the wording of the advertisement should receive careful attention. One should not be stingy of space but should say enough in the advertisement to convince the man looking for help that the advertiser is the person desired. Bragging should be avoided but at the same time one should show that he has confidence in himself. The employer will often find many advertisements for such positions as he has to fill and the advertiser that appears most nearly to meet his requirements will be the first to be considered. Advertisements should be repeated and varied. Vacancies are usually quickly filled but may occur at any time. One may occur soon after an advertisement for such a position has appeared but employers do not read such advertisements unless in need of help and when needing help will not look through many back numbers. Even if the advertisement is repeated a number of times and in several journals it is still an economical way of securing a position.

Traveling salesmen and supply houses often are instrumental in placing men and their friendship should be cultivated.

Finally, in looking for a new position, one should always show consideration for his present employers. A good and safe rule is always to leave a place so that one can go back again. Never try to climb up by pulling another down. It is more honorable to stay down than to climb at the expense of someone else. On the other hand, one can often help himself by helping another and make his position more secure by assisting others to climb with him.

G. E. MILES.

Salida, Colo.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Abbreviations and Volatile Matter

In POWER, December 27, 1910, under the title of "Coal Characteristics," what is meant by the letters after the name of the coals, such as R. O. M., N. P. & S.; also, volatile matter?

F. S. H.

The abbreviation R. O. M. signifies run-of-mine; N. P. & S. means nut, pea and slack. The volatile matter is the hydrocarbon, etc., distilled from the coal at a red heat as distinguished from the solid carbon.

Steam Bound Pump

If a pump frequently became steam-bound, how could it be remedied without reducing the temperature of the water?

A. R.

The head of water in the receiver is not sufficient to lift the suction valves and let the water run into the pump cylinder. This may be because the valve springs are too stiff or because the receiver is not high enough above the pump.

The tension in the springs may be reduced or the vertical distance between the water level in the receiver and the pump increased.

Installing Oil Burner

Please give little information on installing oil burners as to how should the furnace, combustion chamber, bridgewall and general brickwork be arranged to get the best results.

E. W. E.

The grates and bridgewall should be removed from the furnace and the bottom, side and end walls lined with firebrick. The burners should discharge about midway between the bottom of the boiler and the floor of the furnace. No more air should be admitted than is necessary for the smokeless burning of the oil.

Power of Falling Water

What will be the amount of water necessary to run a 50-horsepower water turbine set vertically under a head of 20 feet, and if set horizontally with the same head?

J. O. D.

To develop 50 horsepower requires the expenditure of $50 \times 33{,}000 = 1{,}650{,}000$ foot-pounds of energy per minute. One pound of water falling 20 feet will have 20 foot-pounds of energy and to develop 50 horsepower the water required per minute will be

$$\frac{1{,}650{,}000}{20} = 82{,}500 \text{ pounds}$$

At an efficiency of waterwheel of 75 per cent. the actual water required per minute would be

$$\frac{82{,}500}{0.75} = 110{,}000 \text{ pounds}$$

or approximately 18,000 cubic feet per minute. It will make no difference whether the wheel is set horizontally or vertically if the head and efficiency are the same.

Unloading Boilers

We are about to install new boilers, and as I will have charge I would like to have a little information in regards to the unloading, from the cars. The track is a short spur and it is so arranged that we can drive up alongside of the car. But my intentions are to jack up the boiler high enough so that we can push the car out from under it and then run the wagon under the boiler and let it down on the wagon. If you have a better plan than this, I would like to hear from you. The boilers are 72x18 inches and no dome. As this is the first time I ever had a job of this kind, I would like to do it the best and safest way. What should be the distance between the belly of the boiler and the bridgewall?

F. A. B.

The usual method is to place the wagon by the side of the car and roll the boiler from the car to the wagon on skids. The distance from the bottom of the boiler to the top of the bridgewall should be 10 inches.

Rebounding Dashpot Plunger

What causes a dashpot plunger to rebound after it makes the drop?

W. F. E.

The plunger rebounds because the air valve is open too little and allows more air to be caught in the cushion chamber than is necessary for the proper seating of the plunger.

Efficiency of Injector

What is the efficiency of an injector as a boiler feeder?

E. O. I.

Considered as a pump alone the efficiency is low, but as pump and feed-water heater the efficiency is nearly 100 per cent., as all of the heat not lost by radiation is returned to the boiler.

Lap on Duplex Pump Valves

Why do not duplex pump valves have lap?

L. D. P.

The pump must take steam full stroke, which renders lap inadmissible, as with lap cutoff would occur before the end of the stroke.

Compound-wound Machine with Open Shunt Field Circuit

What effect would the breaking of the shunt field circuit have on a compound-wound dynamo; what effect on a motor?

S. G. R.

The dynamo voltage would be considerably reduced and would become unstable, increasing with an increase of load and decreasing with a decrease of load. The motor would probably tend to run away; it would speed up until its torque just balanced the "pull" of the load, unless it went to pieces before that speed was reached and unless the torque of the load exceeded the torque of the motor with series field excitation alone; in the latter case, which is an improbable one, the speed would decrease until the motor torque balanced the load torque.

Candle Power of an Incandescent Lamp

Can the candlepower of an incandescent lamp be calculated from the watts it takes?

L. B. S.

Not unless you know the "characteristic" of the lamp filament; that is, the relation between watts per candlepower, volts and amperes at different voltages, which is a very uncertain one. A carbon lamp taking 3.1 watts per candle at rated voltage will take 4.7 watts per candle and only 80 per cent. of the total normal watts at 90 per cent. of the rated voltage. The candlepower at this voltage, therefore, would be

$$\frac{3.1 \times 0.8}{4.7} = 0.53$$

(53 per cent.) of the rated candlepower.

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POWER

The Poetry o f the Fireroom

In "Heat a Mode of Motion," Tyndall calls up a picture of the regeneration in a hot box of the radiant energy of an ancient sunshine and of the failure of the man who is trying to cool it off to grasp the real significance of the homely phenomenon.

How many men who are shoveling coal into a furnace realize that they are burning the verdure of a by-gone age compacted by centuries of storage and pressure into the mineral form of coal?

How many realize that in the process of combustion going on under their charge the carbon separated from its oxygen by the subtle action of the sunlight and built into the structure of a forgotten forest is satisfying its long deprived affinity for oxygen; that it is the velocity acquired by these minute bodies rushing together under the force of their mutual attraction and acquiring velocity as does a body falling to the earth impelled by the force which it and the earth exert upon each other, which they see and feel and recognize as heat? That the velocity acquired by the molecules of the gas is communicated to the molecules of steel which compose the heating surfaces and, imparted from one to another of these, is communicated to the molecules of the water until the velocity acquired by them causes them to fly off like the stone from a sling shot and by their impact produce the pressure which moves the engine piston and drives the mill?

To the man who has read Faraday's "Chemistry of a Candle," to whom a coal pile is not a heap of grimy stuff to be shoveled but a heritage from the ages, full of the energy from that source of all terrestrial power, so full that the energy in it would project it to the hight of between two and three miles, who understands the processes of combustion and is interested in carrying them to perfection, the life in a boiler room rises far above the menial and becomes full of meaning and of interest.

The engine room, with its finely designed and highly finished machinery, with its indicator and valve setting and air of applied science, has too long been the center of interest and of effort for the engineer. There is infinitely more chance for applied science in the boiler room. A careless fireman, an illy proportioned furnace, can waste more coal than the most elaborate engine can save. There is more chance for the application of highly specialized knowledge and training in the design and setting of boilers, in the selection and burning of coal, in the treatment and heating of the feed water, than there is in all the processes over which the man in the engine room has any control. Chemistry, physics, mechanics and accounting all have here the wider field and the better opportunity, and managers and owners are commencing to recognize this and to place in responsible charge of boiler-room operations not mere laborers, as has been too often the case, but men who are qualified by education and training to direct the burning of the hundreds of dollars' worth of coal which is used there daily. It is dirty work but it earns clean money and is full of training and opportunity. In a large station near New York, provision is being made for running the boiler room from a bridge or gallery where the trained attendant will have at hand the readings of pressure gages, water meters, CO_2 recorders, flue-gas thermometers, feed-water temperatures and everything that bears upon the continuous and economical operation of the boiler plant, with a laboratory for coal, ash and feed-water analysis and the verification of the CO_2 recording apparatus close at hand.

Only recently the head fireman of a large textile mill was transferred to a new and larger mill of the same company as engineer-in-charge of the entire power plant.

The day may not be so far off when to be the head fireman of a large boiler plant will come to be "some pumpkins."

Mr. Parsons Approves the Initial Velocity Stage

We have several times called attention to the present tendency on the part of steam-turbine manufacturers to use a compounded velocity stage for the initial expansion. The very considerable fall in pressure and temperature before the steam enters the casing relieves the pressure upon the stuffing box and avoids excessive temperature changes, while in turbines of the Parsons or reaction type it avoids the multiplicity of short blades used for the stages which it replaces. It is gratifying to notice that Mr. Parsons himself has placed the seal of his approval upon the practice. In a lecture delivered recently at the Royal Institution, Mr. Parsons said that in the smaller class of land turbine, the high-pressure

end of the reaction turbine has always been less satisfactory than the lower-pressure section. On account of the low blade speeds the number of rows required had been large, which had added to the length of the shaft, reducing its stiffness and increasing the allowable clearance. He did not, however, approve of the use of two or more of these velocity compounded stages before passing the steam to the reaction blading.

Advantages of Safety Appliances

Simplicity of design in power-plant equipment is undoubtedly wise engineering practice. Complicated machinery will, of course, give more trouble than that of simple design, and, likewise, the more machines or devices put in a plant the more chances there are for trouble to arise.

Many engineers put in no more apparatus than is absolutely necessary to operate the plant in an economical manner. In fact, some plants are so simple in equipment that they are nothing more than a small country isolated plant enlarged. Ordinary boilers, hand-fired furnaces, water columns and gage glasses, steam gages and safety valves, the necessary appliances for safety, and Corliss engines with the necessary pipes and fittings comprise the outfit.

An engineer can look over such a plant and congratulate himself on the design, on the absence of a hundred and one so called "frills" and especially so if he can operate more efficiently than other steam plants which contain more elaborate equipment.

There are, however, various apparatus that could well be installed, and, although they might not be called upon to perform their function for years, perhaps never, their presence gives a sense of security and if occasion does arise their worth in preventing a serious accident will prove a paying investment.

An engineer may debate as to the advisability of equipping his engines with a speed-limit safety device, and finally decide that one is not necessary. But a few months after the plant has been started up the governor gear becomes deranged, a flywheel goes to pieces and beside doing a lot of damage to the plant, kills the engineer on watch. Under such a circumstance the safety stop would have been a mighty good investment.

While this incident is cited as an example of what might happen it is at the same time a good illustration of what has happened.

Another engineer designs a steam plant along sound engineering lines. To him the matter of a nonreturn valve in the main steam line comes up. The matter is thought over and the decision arrived at is that the services of the valve would not be required once during the life of the plant. The decision is not a rash one; hundreds of steam plants have operated for years without such a valve, and were none the worse off. Nothing ever gave way, and the valve would have only been an additional first cost.

But, on the other hand, suppose that a nonreturn valve had been put in the line, and a steam pipe had burst or a valve or a blank flange fractured from water hammer or some other cause, the valve in the main steam line would stop the flow of steam and it is evident that the damage from escaping steam would be insignificant as compared to what would be done if the boilers emptied themselves, or valuable minutes were used in closing stop valves over the boilers by hand.

Using precaution is a good thing, and if one is to ere in the matter of safety devices it is better to ere on the side of safety.

A Friendly Suggestion

It would probably surprise most of our readers to know how many letters of inquiry concerning engineering matters we answer by mail each week. Nothing gives us more pleasure than to help a reader over a rough spot, however, and we do not begrudge the huge volume of correspondence involved; but we wish to offer one suggestion to any and all who may desire information: Before asking us for it, see if you cannot find it in some back number of the paper; if you can, you will not need to ask us for it. If you are unable to find in your back numbers what you want to know, write and we will gladly answer your letter—this is not a kick, merely a suggestion inspired by the fact that within two weeks we have answered by mail nine requests for information that had been printed in POWER within a year—some of it within a month.

Getting the Full Benefit

It is the common experience of most readers of engineering papers that upon looking through an old number of a paper one is likely to find an article that is of much interest and value and that the reader does not remember having seen at the time when that number of the paper was received. This experience proves conclusively that the man who has it is not getting the full benefit of the fund of material presented by his periodicals.

The remedy is simple: A card index. If every reader of POWER, for example, would preserve his copies and keep a card index of all subjects discussed in them—not merely those subjects which interest him at the moment of publication—he would have a "ready-reference" library in a few years that would be astonishing.

There is another method of making published information readily available; that is the scrap-book method. It entails the disadvantages, however, of not being able to classify an article under more than one head and of having to get an extra copy of almost every issue of the paper in order to paste clippings from both sides of a leaf. The card index is simpler, takes less time and is more general in scope and flexible in application.

The Fusibility of Ash

A great deal of emphasis has lately been placed by E. G. Bailey, M. E., of Boston, on the fusibility of ash. A coal having but a small percentage of ash the fusing point of which is below that obtaining in the lower strata of the fire will be a very troublesome and uneconomical fuel, for the ash will melt and run together, forming a plaster clinker which flows over the grates, shutting off the air supply, requiring the constant working of the fire, reducing the efficiency of the furnace by lack of continuity of operation and by restricting the supply of oxygen and involving a large percentage of carbon in the ashpit waste. On the other hand, a coal comparatively high in ash will work quite satisfactorily and reach its limit much less quickly if the nature of its ash is such that it will not melt at the ordinary furnace temperatures. Although the weight of ash produced in a given time is greater it remains in the form of powder and can easily be gotten rid of with a few passes of the fire tools or a movement or two of the grate. Mr. Bailey is able by determining the fusibility of its ash to estimate the real fuel value of a sample of coal and to predict its behavior much closer than by any analysis or determination of heat content.

Have you noticed that some managers will listen to a mud carrier? In the end they generally find that the mud soon turns to dust and blows away.

Conservation of water power means its use. Every drop that flows to the sea is just that much power lost forever.

Have you noticed that some men are always so busy that it is a wonder they can find time to sleep and eat?

Investors in water-power developments want to know what the Government will do with their property at the end of a limited franchise.

A man may have knowledge, but lacking energy will not amount to anything.

An engineer cannot get experience for nothing; it must be paid for.

Refrigeration Department

With this issue we start a refrigerating department. Hitherto, we have published miscellaneous articles at odd intervals, but have decided that the subject is of enough importance to our readers to give it a definite location in the paper. From now on this department will appear every second issue. Contributions on the practical operation of refrigerating machinery and apparatus are especially solicited, and will be received as a token of the interest taken in the department.

Principles and operation of ice making and refrigerating plant and machinery

The Specific Heat of Calcium Chloride Brine

By H. G. Fairview

The true specific heat of brine is often of great value in determining the performance of refrigerating machinery. It is a well known fact that the specific heat of water is not constant but varies with the temperature; and the use of steam tables, in which this variation is taken into account, for finding the "heat of the liquid" at any temperature is familiar to all engineers. The steam tables are calculated for pure water, the specific gravity of which is unity.

If a salt, such as calcium chloride, is added to the water the solution is known as brine, the specific heat of which varies not only with the temperature but also with the density; the denser the solution the less the specific heat. A dense solution is one containing a large amount of salt, that is, one having a high specific gravity. This variation with two quantities makes the task of preparing a comprehensive table of specific heats more complex because of the large number of brine densities that are in common use. So far as the writer knows there was not until quite recently any effort made to prepare such a table.

While doing some experimental work with a refrigerating plant a little more than a year since, it was necessary to know the specific heat of the brine accurately in order to make a heat balance for the system. A careful search failed to reveal anything more extensive than the well known tables of Landolt and Börnstein, giving the specific heat of various brine solutions at from 59 to 64 degrees Fahrenheit, but without any statement as to the variation with the temperature. All other available tables gave the specific heat at about the same temperature, and moreover the values did not show good agreement besides being for temperatures much above that of the test.

The only apparatus available at the time for finding the specific heat was a Parr coal calorimeter. The determinations were made with this, using standard benzoic acid of known heating value as the source of heat. At that time plans were made to go into the work more fully, and to use Dewar flasks instead of the calorimeter in order to reduce the radiation loss, and an electric heating coil instead of the benzoic acid. The Dewar flasks were purchased, but before the work was begun the Bureau of Standards published a bulletin on "The Specific Heat of Some Calcium Chloride Solutions Between — 35 degrees Centigrade and + 20 degrees Centigrade," giving the desired information in detail. The work was very carefully done by an electrical method, with all possible refinements, and the values may be taken as correct.

The results are presented both in tabular and graphical form for the various solutions. And further to make the results apply to all possible densities the authors have deduced the following empirical formula which represents their results to within 0.1 per cent.

$$D = 2.8821 - 3.6272\,S + 1.7794\,S^2$$

D = Density at 20 degrees Centigrade or 68 degrees Fahrenheit;

S = Specific heat at 0 degrees Centigrade or 32 degrees Fahrenheit.

For each degree Centigrade change in temperature the specific heat changes by an amount varying from 0.0006 to 0.0009, the usual value being between 0.0006 and 0.0007. In all cases the specific heat decreases with the temperature; the correction value 0.0009 applies only to brine of density 1.200 at temperatures below — 10 degrees Centigrade.

It is interesting to compare the results given by this equation with that obtained with the Parr calorimeter. The mean of two calorimeter determinations for brine of density 1.204 gave the value of the specific heat as 0.6944. Applying the formula to the same solution and solving:

$$Sp.\ Ht.\ at\ 0^\circ\ C. = 0.7098$$

Making the proper temperature correction to change to 0 degrees Fahrenheit,

$$Sp.\ Ht.\ at\ -17.7^\circ\ C. = 0.6939$$

The difference between the two results is 0.0005, a percentage difference of 0.07 per cent. This is a remarkable agreement when one considers the practical difficulties of making such determinations at low temperatures. The equation gives equally as good results at higher temperatures. From Landolt and Börnstein's tables for a density of 1.231 at 60 degrees Fahrenheit, the specific heat is 0.700. Using the above equation the result is

$$Sp.\ Ht.\ at\ 0^\circ\ C. = 0.6859$$

Applying the temperature correction,

$$Sp.\ Ht.\ at\ 60^\circ\ F. = 0.6968$$

It is well at this point to call attention to the fact that the Bureau of Standards' values are slightly lower than Landolt and Börnstein's and differ considerably from some commercial tables.

The above formula was deduced for chemically pure calcium chloride solutions, but the experimenters found that the specific heats of various commercial solutions differed from that of the chemically pure by less than 0.5 per cent., being in some cases higher and in others lower; so that for practical purposes the formula may be safely used, and may be expected to give more reliable results than a direct determination because of the difficulty of making the latter at low temperatures. The formula is convenient, as it needs to be solved only once for each density.

In applying the formula the following points should be kept in mind:

First: Determine the density at or near 20 degrees Centigrade (68 degrees Fahrenheit).

Second: The equation gives the specific heat at 0 degrees Centigrade (32 degrees Fahrenheit).

Third: That this result must be reduced to the desired temperature conditions as before noted.

The importance of determining the density at the proper temperature is shown by the following table, showing the variation of density with the temperature:

7 degrees F.	density = 1.2165
12 degrees F.	density = 1.2150
15 degrees F.	density = 1.2140
20 degrees F.	density = 1.2135
25 degrees F.	density = 1.2125
30 degrees F.	density = 1.2115
38 degrees F.	density = 1.2090
45 degrees F.	density = 1.2080
52 degrees F.	density = 1.2070
60 degrees F.	density = 1.2050

Problem in Refrigeration

By F. E. Matthews

How much refrigeration will be produced by the circulation of 50,000 *cubic feet of brine per month, the average temperature going out being* 28 *degrees Fahrenheit and that of the return* 32 *degrees?*

The amount of cooling that a given quantity of brine will do depends not only upon the number of degrees rise in temperature, but upon the density and kind of brine. As the problem does not state whether the brine used is calcium or salt or what its density is, it may be well to show how the problem is solved in the general case and illustrate by taking a single example based on assumed conditions.

The most important element in the selection of the kind of brine to use is the temperature to be produced, which fixes the temperatures at which the brine must be circulated. Saturated salt brine, by which is meant brine so strong that it will dissolve no more salt, freezes at about 5 degrees Fahrenheit below zero and would be safe for brine-tank temperatures above zero. Salt brine of lower densities freezes at correspondingly higher temperatures, the limit being reached when the amount of salt is reduced to nothing in which case the brine becomes water and freezes at 32 degrees Fahrenheit.

Saturated calcium brine freezes at about 55 degrees Fahrenheit below zero and according to its densities is adapted to brine temperatures from 40 degrees below zero up. The specific heat of either salt or calcium brine upon which depend their refrigerating capacities per pound per degree rise in temperature, decreases as the strength increases.

The refrigerating capacity of water per pound per degree rise in temperature is one British thermal unit. As salt or calcium chloride is added to the water this value decreases until its value at saturation (maximum strength) is only 0.77 B.t.u. In the latter case, about 30 per cent. more brine must be circulated, to accomplish a given amount of cooling for a given rise in brine temperature, than would be necessary were the desired temperatures sufficiently high to allow water to be employed as a medium for conveying heat, instead of brine. Tables showing the properties of salt brine and calcium brine are published in almost every handbook on mechanical refrigeration as well as in many ice-machine catalogs.

The unit by which cooling effects are measured is the ton of refrigeration. This is equal to the amount of cooling produced by the melting of one ton (2000 pounds) of ice having a latent heat of fusion of 144 B.t.u. per pound. Cooling at the rate of one ton per day would amount to the extraction at a uniform rate of

$$2000 \times 144 = 288{,}000 \textit{ B.t.u.}$$

per 24 hours;

$$288{,}000 \div 24 = 120{,}000 \textit{ B.t.u.}$$

per hour or

$$288{,}000 \div (24 \times 60) = 200 \textit{ B.t.u.}$$

per minute.

The amount of refrigeration, expressed in tons T per 24 hours, produced by a rise in temperature from t_1 to t_2 of a certain number of pounds p of brine circulated per minute and having a specific heat s, would be,

$$T = \frac{S\,(t_1 - t_2) \times p}{200} \qquad (1)$$

If p represents the number of pounds of brine circulated per hour, or per 24 hours, the expression would be the same except the constant 200 would be replaced by 12,000 and 288,000 respectively.

The circulation of 50,000 cubic feet of brine per month is equivalent to

$$\frac{50{,}000}{30 \times 24 \times 60} = 1.157 \textit{ cubic feet}$$

per minute. Assuming that it has the specific gravity commonly employed of 1.2, its weight per cubic foot will be

$$62.5 \times 1.2 = 75 \textit{ pounds}$$

or

$$75 \times 1.157 = 86.775 \textit{ pounds}$$

will be the amount circulated per minute under the given conditions. The rise in temperature as given in the original problem was from 28 to 32 degrees Fahrenheit and the specific heat of brine having a specific gravity of 1.2 is 0.7. Substituting these values in formula (1)

$$T = \frac{0.7\,(32 - 28) \times 86.775}{200} =$$

$$\frac{242.97}{200} = 1.2148 \textit{ tons}$$

A rough rule for calculating the number of tons of cooling effect produced by brine is to allow 25 heat gallons per minute per ton. Apply this rule to the foregoing case as follows: Since 1 cubic foot equals 7.48 gallons, 1.157 cubic feet equals 8.654 gallons and the rise in temperature is 4 degrees Fahrenheit. Hence,

$$8.654 \times 4 = 34.617 \textit{ heat gallons}$$

which is equivalent to

$$\frac{34.617}{25} = 1.38 \textit{ tons}$$

an amount somewhat larger than that given by the regular formula.

The percentage of saturation or the specific gravity having been determined, a table, giving the properties of the kind of brine employed, may be referred to and the specfic heat, corresponding to that density, found. Also the weight of the brine per gallon may be found and from this may be calculated the weight of brine circulated per minute. These quantities should then be substituted in formula (1) and the result will be the required cooling effect expressed in tons per 24 hours.

This approximate rule is intended to apply roughly to brines of the higher densities and, since it does not take into consideration possible variations in the value of the specific heat of the brine, it cannot be expected to apply accurately to brines of all densities. For example, according to formula (1) the amount of refrigeration produced by the circulation of 200 pounds of water per minute with a rise in temperature of one degree Fahrenheit would be

$$T = \frac{1 \times 200 \times 1}{200} = 1 \textit{ ton}$$

According to the rule, which ignores the specific heat of water, which is unity, the cooling effect would be, since 200 pounds of water is equivalent to 24 gallons,

$$\frac{24}{25} = 0.96 \textit{ ton}$$

For accurate determinations of the cooling effect the density of the brine should be determined by either a salonometer or some other form of hydrometer that will allow either the percentage of saturation or the specific gravity of the brine to be determined. In taking such hydrometer readings care should be taken to bring the temperature of the brine to that at which the instrument is calibrated. This method is less likely to lead to error than that of applying a correction factor for reducing the readings taken at other temperatures to what they would be if taken at the standard temperature.

Device for Charging an Absorption Ice Machine

By T. H. De Saussaure

It is often difficult to make a pump take suction from a drum of aqua ammonia when it is desired to add to the charge of an absorption ice machine while it is in operation. This is particularly true when the ammonia in the drum is warm, as the gas given off destroys the vacuum in the suction pipe, and the pump will not lift the ammonia.

Having a machine which required constant additions to the charge, I devised the following arrangement, which makes the operation a very simple and sure one.

I first built a substantial table large enough and strong enough to sustain the weight of a drum of ammonia, and placed upon the top of this table four friction rollers, as shown in Fig. 1. The rollers are each made of oak, 8 inches in diameter, and have a piece of 1-inch round iron through the center for the axle. When mounted on these rollers the drum is on a higher level than the pump, and can be easily rolled over until the bung is on the under side.

I then took a piece of 3½-inch wrought-iron shafting, 4 inches long, and turned and threaded it so that it could be screwed into the bung hole of the drum. Through this plug I made an opening

for a suction pipe and another for an air pipe, Fig. 2. The air pipe is made of ⅛-inch wrought-iron pipe and is of such length that it will reach to within 1 inch of the side of the drum diametrically opposite the bung plug when the latter is screwed to a joint in the bung. Both the suction-pipe connection and that of the air pipe have valves on them, placed near the plug.

When it is necessary to add to the charge of ammonia in the machine the fresh drum is placed on the table and the new plug, with both air and suction

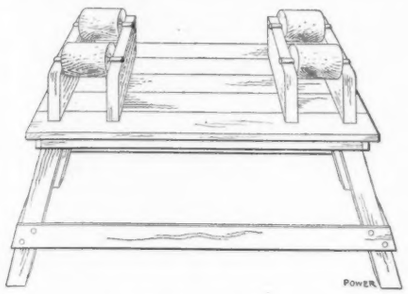


FIG. 1. BENCH FOR HOLDING AMMONIA DRUM

valves shut, is used in place of the one usually sent. The drum is then turned on the friction rollers until the bung is on the bottom. Connection is then made between the suction opening on the bung plug and that of the ammonia-circulating pump, and between the air pipe on the bung plug and the discharge opening of an ordinary plumbers' force pump. About five pounds of air pressure is pumped into the drum with the force pump; then the valve on the suction pipe is opened and the pump takes suction immediately.

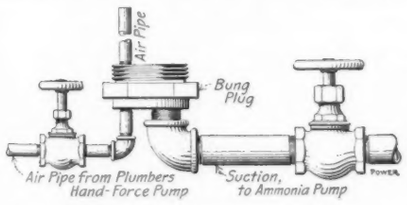


FIG. 2. ARRANGEMENT OF PIPING TO PUMP

I have never had it fail in several years' use. It is necessary to keep a slight pressure in the drum so that the air may take the place of the ammonia pumped out.

The objection might be raised that there is danger of getting a quantity of air into the machine after the ammonia is all pumped from the drum; but if the ear is held against the head of the drum while the pumping is being done, one can detect the instant when the last drop of liquid is pumped out and the suction valve can be shut immediately.

The device has this advantage also—one can get the last drop of ammonia out of the drum and into the machine without any waste at all.

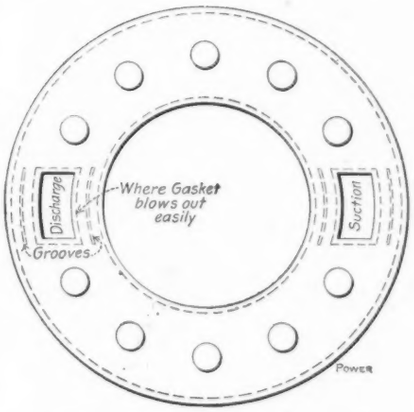
LETTERS

Fitting a Gasket on Compressor

Gaskets for the head of the ammonia cylinder of a vertical ice machine often cause trouble when not put on properly. The gasket frequently blows out into the water jacket or into the cylinder, specially where a pressure of 160 to 180 pounds or perhaps higher is carried. In nine out of ten cases the gasket gives out on the discharge side.

When a gasket is put on as illustrated, it will hold if the surfaces of the cylinder flange and the head are smooth. The old gasket should be scraped off on both surfaces, and to remove the grease use a clean cotton or linen rag (no waste) moistened with coal oil. Then take another clean rag and wipe off the coal oil.

The best rubber available should be used and it should not be thicker than



GASKET FOR AMMONIA CYLINDER

1/16 inch. The gasket should be cut accurately and the holes must fit snugly over the studs. The edges of the gasket where it is cut out for the suction and discharge should lap a little over the openings. No graphite or oil should be used on the gasket or metal surfaces, so that the gasket will not slip when tightened. It is very important to see that the nuts are tightened evenly. They should be tightened up with the fingers first and then with the wrench, starting with one nut and then following up on the nut diametrically opposite. It is a good plan for two men to do the tightening on the first six nuts. Then one wrench should be used by the two men to complete the job, starting on one nut and going all the way around.

Once I ran a machine on which no gasket would hold tight. It was always blown out into the cylinder, no matter how carefully it was put on. A small groove was cut around the discharge opening, as indicated in the drawing, which proved to be a success. If a gasket blows out into the cylinder the defect may be detected by a sharp hissing noise, a hot suction pipe and an unusually high back pressure.

When the head of an ammonia cylinder, where no graphite was used, has to be taken off and a chain fall will not do the trick, loosen the nut at the crosshead and screw the rod out about three or four turns; then turn the engine over by means of the starting bar and the head will be forced off.

WILLIAM L. KEIL.

Philadelphia, Penn.

Connecting Ammonia Compressor

In answer to H. S. Free in the March 21 issue, I would advise the following:

In the first place, he does not state the combined capacity of both condensers, which would assist in explaining what is best to do.

First of all, a 2-inch pipe for a discharge on a 50-ton machine is too small; it should be at least 3 inches. The 35-ton machine should have a 2½-inch discharge pipe. The total area of these two pipes would be over 12 square inches, so it is plain that all the gas from the two compressors cannot pass through the one 2-inch three-way valve. It is ridiculous to attempt such a thing. It would be advisable to connect both condensers with a bypass so that either or both combined could be used for either compressor. But by all means increase the size of the discharge pipe from each compressor to the condenser and make a 2½-inch bypass at a convenient place, with as few elbows as possible. The three-way valve would do in the bypass if your employer will not allow the expense of a larger one.

WILLIAM NOTTBERG.

Kansas City, Mo.

A recent issue of the *Brass World* contained a simple method for removing rust from surfaces that were afterward to be electroplated; but the method might be applied equally well to other rusty surfaces. It consists in dipping the articles first into a strong, hot potash bath for about half an hour, and then immersing in a cold muriatic-acid pickling solution, composed of two parts of water to one of acid. This removed the rust in a few minutes, leaving the metal apparently attacked but very little. The previous soaking in the strong, hot potash solution is responsible for this rapid pickling, as a test proved, for without the previous dipping 65 minutes were required by the acid bath, against four minutes when previously treated in the potash bath. Apparently a chemical reaction is set up, changing the character of the rust, softening it and making it readily soluble. The appearance of the rust as it comes from the potash kettle testifies to this.

Handling Coal in a Modern Boiler Room

Probably no two boiler rooms in modern buildings present quite the same problems for solution. Conditions of location, space and requirements are such widely varying factors that the engineer is constantly called upon to devise new methods of adapting modern devices to suit his precise needs and yield the highest efficiency.

An ideal system would enable the coal to be dropped into the bunkers direct from the car or lighter, and fed to the grates without rehandling. This is manifestly impossible in any modern city building—or indeed in any but a few boiler rooms enjoying an exceptionally favorable situation.

An interesting solution of a coal-handling problem is found in the new Fifth Avenue building at the corner of Twenty-third street and Broadway in New York City.

There are 2000 horsepower of Heine boilers, equipped with automatic stokers. The transfer of the coal from the bunkers to the hoppers of the stokers is effected in this instance in iron buckets holding about 600 pounds. These buckets are hung from the hook of a Yale & Towne electric hoist, which in its turn is built into a trolley running on an overhead track leading from the bunkers to the hoppers of the various stokers.

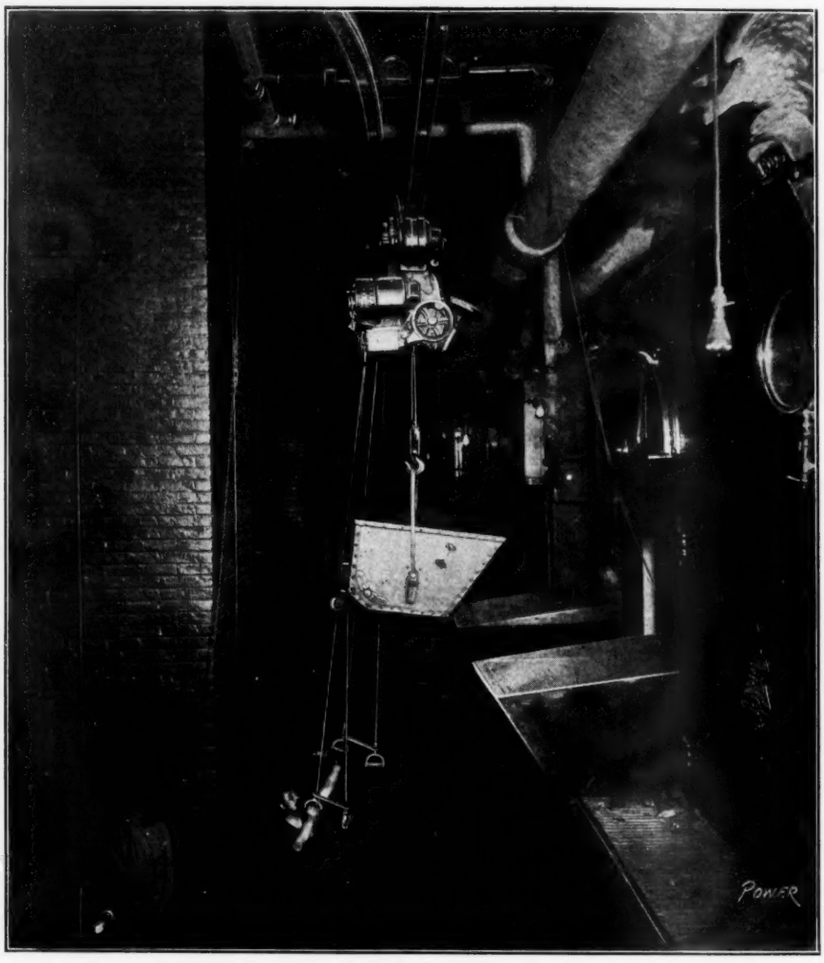


FIG. 1. YALE & TOWNE HOIST AND 600-POUND COAL BUCKET

The boiler room is located three stories below the street level and the coal supply is carried in bunkers, which are as favorably located in relation to the boiler room as the general conditions will permit.

In operation, the buckets are lowered to a point opposite the mouth of the bunker chute to permit the coal to flow into them by gravity from the bunkers. A pull on the switch then starts the electric hoist and the bucket is lifted high enough to enable it to start on its journey to the hoppers of the stokers.

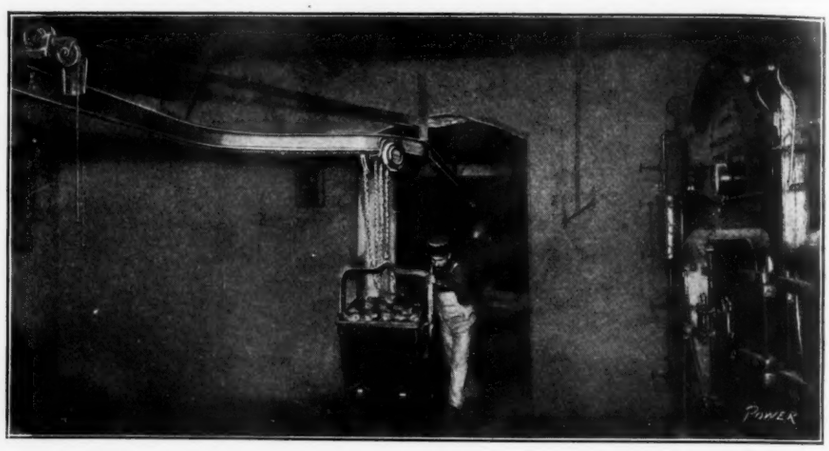


FIG. 2. HOIST PICKING UP ASH CAN

This journey, accomplished by means of a smaller motor (attached to the trolley) which is geared to and drives the trolley wheels, is made in a few seconds, and the coal is then dumped into the hoppers of the stokers.

A switch in the overhead track enables the hoist to be run to a point where it can pick up the ash cans.

The whole electrical installation is under the control of the operator. The hoist will raise or lower the bucket by fractions of an inch, if necessary, and the load is automatically held at all times. The control of the trolley motor is also quite as complete, and the load may be advanced or withdrawn at will.

The hoisting problem in this case is not in itself particularly difficult, but the conditions under which the hoist operates are severe. The temperature at the top of the boiler room probably averages 135 degrees and a considerable amount of dust and fine particles of coal is naturally present. Up to the present writing the hoist has continued to perform its work satisfactorily, and no diminution in efficiency has been apparent.

It is reported that the New York, New Haven & Hartford railroad is equipping a number of its locomotives with oil burners. Oil has been used successfully and with considerable saving by a number of railroads in the Southwest, but the relatively high cost of this kind of fuel in the central Atlantic and New England States has been largely responsible for its limited use. Undoubtedly the locomotive, where, due to the excessive draft, a large percentage of the coal goes up the stack, furnishes an attractive field for the application of oil fuel.

New Power House Equipment

What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news

The Thomas Electric Gas Meter

Some time since Prof. Carl C. Thomas, now of Madison, Wis., made, at Schenectady and later at Sibley College, some experiments upon the specific heat of superheated steam, the results of which were given in a paper presented by him

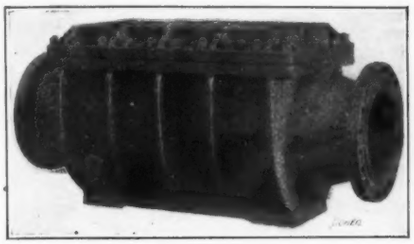


FIG. 1. CASING FOR THOMAS METER

to the American Society of Mechanical Engineers in 1907 and published in Volume XXIX of the *Transactions*. The method was to pass steam, known to be dry, through an electric heater, and to note the amount of current necessary to raise its temperature an observed amount. The weight of steam treated was determined by condensing and weighing it. Reducing the electrical energy to its equivalent in heat units, and knowing the weight of steam heated and the number of degrees its temperature was raised, it was a simple matter to compute the amount of heat necessary to raise one pound one degree on an average for the observed range.

Later Professor Thomas reversed the process and produced a meter for gases which was described in a paper presented by him to the Mechanical Engineers in 1909 and published in Volume XXXI of the *Transactions*. If the specific heat of a gas is known, the weight passing through the device can be determined by measuring the electricity necessary to heat it a given amount; that is, by ascertaining the increase in temperature produced by a known amount of energy. Reducing the measured current to its heat equivalent gives the B.t.u. expended and knowing the number of B.t.u. necessary to raise one pound of the substance one degree the determination of the number of pounds necessary to absorb the observed amount of heat when heated through the observed range is a matter only of simple division. In the commercial form of the meter this process is automatically carried out in such a manner that the record, either indicating, graphically recording, or integrating, reads directly in "standard cubic feet" of gas per unit of time.

FIG. 3. SCREEN OF RESISTANCE WIRE FORMING THERMOMETER

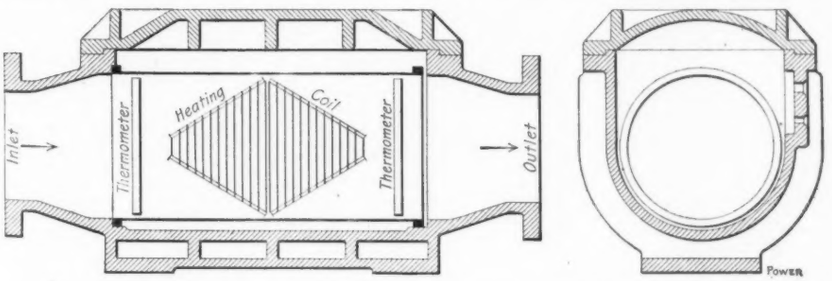


FIG. 2. SECTIONS OF METER CASING, SHOWING POSITIONS OF HEATER AND THERMOMETERS

In the latest form of the meter a constant temperature rise of about two degrees Fahrenheit is preserved, and the regulating mechanism necessary to effect this as well as the perfection of recording mechanism brought it within the field of the Cutler-Hammer Manufacturing Company, of Milwaukee, which is putting it upon the market.

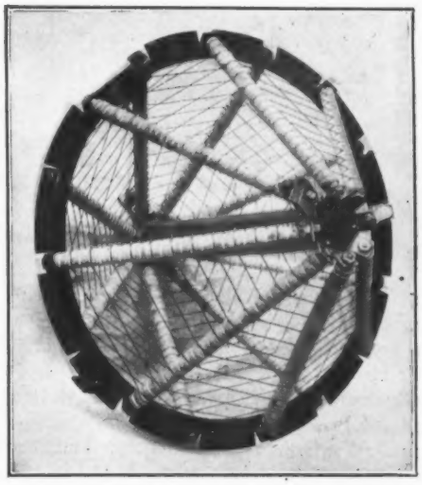


FIG. 4. HEATER LOCATED IN METER CASING SHOWN IN FIG. 2

The meter proper, as they make it, is shown in perspective in Fig. 1 and diagrammatically in Fig. 2. A meter having a 16-inch outlet will take care of 750,000 cubic feet per hour.

The thermometer consists of a continuous length of very fine nickel wire, the electrical resistance of which varies considerably with its temperature. This is carried back and forth in parallel lines across a circular frame, as shown in Fig. 3, and bound by silk threads crossing it at right angles. One of these thermometers is placed at the inlet and another at the outlet end of the meter. Between them is placed a heater, shown diagrammatically in Fig. 2, and in perspective in Fig. 4. This is simply a resistance coil wound upon a double conical frame so that all the gas passes over a heated wire. The thermometers form the two sides of a Wheatstone bridge and the current is regulated so as to maintain a constant temperature difference between them in the manner shown diagrammatically in Fig. 5. The controller is, in effect, a galvanometer and Wheatstone bridge combined. The movable member is caused to swing to the left or right

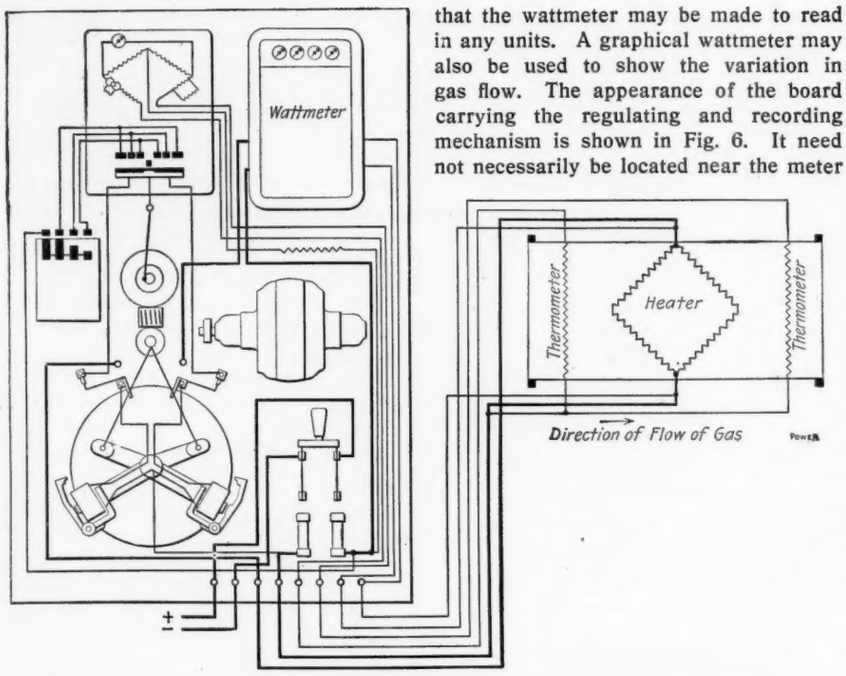


FIG. 5. DIAGRAM OF ELECTRICAL CONNECTIONS OF THOMAS METER

that the wattmeter may be made to read in any units. A graphical wattmeter may also be used to show the variation in gas flow. The appearance of the board carrying the regulating and recording mechanism is shown in Fig. 6. It need not necessarily be located near the meter but may be in the manager's office or at any convenient point.

When the physical condition of the substance measured does not change by reason of the heating, as by the drying out of moisture, and when the specific heat is known the meter would seem to promise a solution of the difficult problem of measuring gas and air in large quantities with considerable accuracy. When the material contains moisture it is suggested that a drier consisting of a steam coil be used just before the meter. With regard to measuring saturated steam the uncertainty of complete dryness and the serious effect of the absorption of heat in evaporation, may complicate its use as a steam meter, for which indeed, we do not know that it is intended. Superheated steam can, however, be successfully measured by a meter of the kind described. For a stable substance like natural gas with a practically constant specific heat it has been doing excellent work for some time. For artificial gas and other products occasional analyses will enable the specific heat to be determined with sufficient accuracy for commercial purposes.

of a fixed position according as the difference in resistance of the thermometers is greater or less than that corresponding to the desired temperature difference of two degrees between the inlet and outlet of the meter. The motor (⅛ horsepower) operates continuously, and by means of a crank causes a bar to move up and down, clamping the needle at the top of the stroke. It also drives, at a slow but constant speed, a contact drum and two eccentrics which give the rheostat pawls a reciprocating motion through a small arc along the edge of a toothed wheel on the rheostat shaft. On the drum are three segments of different lengths corresponding to one, two and three teeth on the wheel. If the needle is clamped in position on the right of the zero position the solenoid on the pawl which will turn the rheostat in the direction to increase the heater energy is energized and holds the pawl up long enough to move the wheel one step and it will continue to do this until by successive strokes the rheostat has been turned enough to restore the desired temperature difference and thus balance the system. A very slight fall of temperature in the gas will cause it to do this. When the temperature difference is restored the needle returns to zero, makes no contact when it is clamped and the rheostat remains stationary. If the temperature difference increases above two degrees the needle swings to the left of the zero mark and the same process works to reduce the current. The wattmeter in the upper right-hand corner shows the energy which has been used to heat the gas, which is proportional to the amount flowing, so

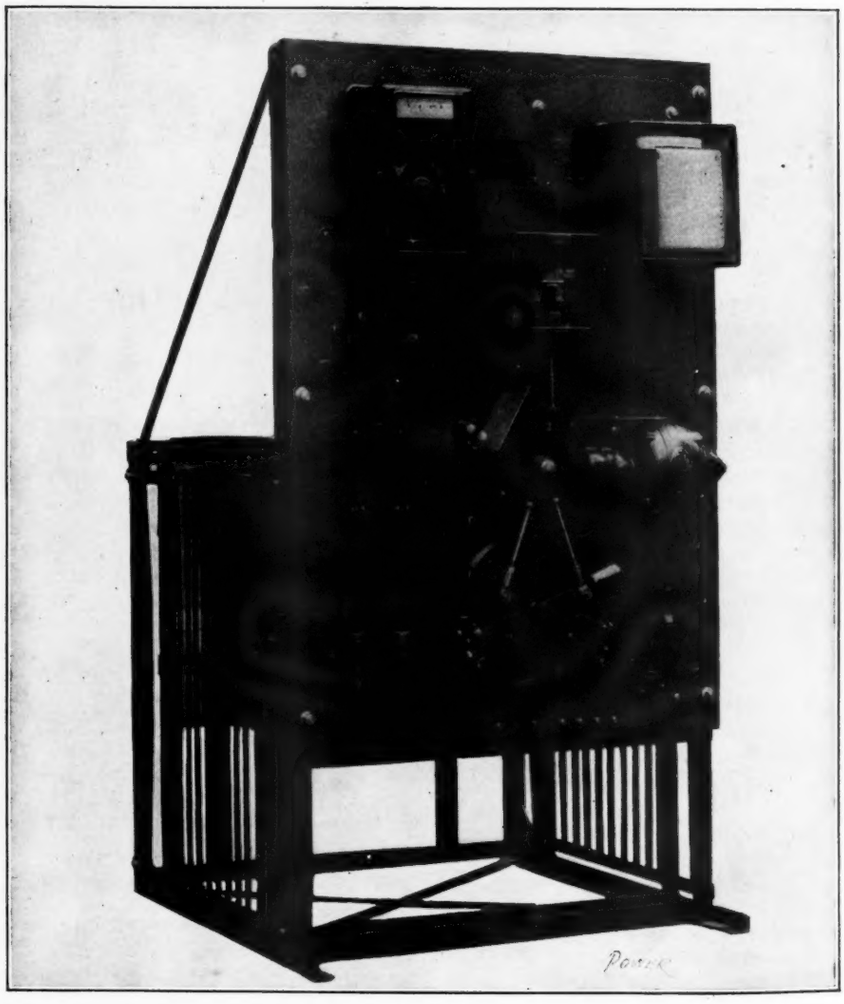


FIG. 6. SWITCHBOARD AND RECORDING INSTRUMENTS FOR THOMAS METER

Detroit Three Way Valve

The accompanying illustration shows the Detroit quick-opening three-way valve, which is used on water-cooled gas and gasolene engines to turn the necessary amount of water into the water-cooled muffler or exhaust, after it has passed through the water jacket on the cylinder, and has turned the rest of the water to waste.

This valve permits any quantity of water to be diverted into the muffler by a slight turn of the indexed valve handle. All the rest of the water goes to waste without any further regulation.

The valve consists of a globular body with three openings, one at the base through which the water enters and two

DETROIT THREE-WAY VALVE

at the sides, at right angles to each other. The shell is so arranged that all of the water coming up through the opening in the base can be turned through either one of the side openings or it can be graduated to divert any required volume of water through either of the openings and turn the rest through the other hole. The handle is indexed and shows what proportion of water is wasted.

The valve is manufactured by the Detroit Lubricator Company, Trumbull avenue, Detroit, Mich.

The blowing off of a cylinder head at the works of the Hope Webbing Company at Pawtucket, R. I., on the afternoon of April 15, caused two men to be painfully, if not seriously, scalded. The peculiar feature about the accident is that the steam was shut off at the time.

Fatal Tube Blowout in Winsted, Conn.

BY GEORGE L. STRAIT

A fatal accident occurred at the woodworking plant of J. H. Rowe in Winsted, Conn., on Saturday, April 15. The owner, Mr. Rowe, sustained severe injuries and lived only a few hours. The cause of the accident was a defective tube. The boiler is of the locomotive type, having sixty 3-inch tubes, and is used for heating the shop and dry kiln, and carried from 40 to 50 pounds gage pressure. It has been in the Rowe plant for 18 years and was an old boiler when installed. Upon examination it was found that four tubes in the bottom row and two in the second row from the bottom were stopped with pine plugs which had been driven in with no rod running through the tubes to hold them in place. The stem on the handhole plate was badly corroded and looked as if it had not been taken out in years. The safety valve was of the ball and lever type, and an effort to raise it showed that it was stuck fast. I learned from an employee at the plant that the boiler had never been cleaned to his knowledge since being installed.

It is the writer's impression that there was from 6 to 8 inches of mud in the bottom as this could be seen from the place where the defective tube burst. The ends of all the tubes in the two bottom rows were corroded so that they could easily be broken off with a hammer. From all reports the boiler had never been inspected.

Mr. Rowe was fixing up the fire for the night when the accident occurred. The door in front of the boiler room was closed so that he could not escape that way on account of the steam and hot water; he finally got out through a window and his cries attracted a passerby who came to his assistance.

This is another case of negligence on the part of owners and operators of steam plants. The laws of Connecticut are very lax in this respect; there is no law requiring experienced men to be employed in caring for steam plants, although there is a bill before the present house of representatives which, if passed, will in a measure remedy this deficiency.

A 110-foot steel smokestack in course of construction at the factory of the Keyes Products Company at Montville, Conn., collapsed on Saturday, April 15, as the third section was being raised into position. The tackling appears to have slipped in some manner, allowing a piece of steel weighing several tons to fall and crash through the roof of the mill building below. Fortunately no one was hurt, although several workmen had narrow escapes.

SOCIETY NOTES

At the last meeting of the executive committee of the Institute of Operating Engineers, Hubert E. Collins was elected secretary in place of M. W. Rice, resigned. W. P. F. Hill was elected treasurer in place of Adam Harkness, whose term had expired.

J. B. Embrey, secretary of the Practical Refrigerating Engineers Association, with headquarters in Shreveport, La., reports that the growth of the association since its organization last December has been phenomenal and has far exceeded the most sanguine expectations. The association is composed of white refrigerating engineers of good moral character, who have had one or more years' experience in operating ice and refrigerating plants.

Several important papers on "Patents" will be presented at the New York meeting of the American Society of Mechanical Engineers, 29 West Thirty-ninth street, on Tuesday, May 9. The subject will be discussed by E. W. Marshall, D. Howard Haywood, Edwin J. Prindle, all of New York. The purpose of this meeting is to outline to the engineer and manufacturer the fundamental principles of the patent law, the position and qualifications of a patent expert and the industrial development for the purpose of establishing a patent monopoly.

PERSONAL

Frank B. Davenport, who has been employed by the G. B. Markle Company in the mechanical department to design a new breaker at Harleigh, Penn., resigned recently to open a consulting engineer's office in Wilkes-Barre, Penn.

BOOKS RECEIVED

THE ENGINEERING INDEX ANNUAL FOR 1910. The Engineering Magazine, New York. Cloth; 496 pages, 6½x9¼ inches. Price, $2.

SCIENTIFIC MANAGEMENT AND RAILROADS. By Louis D. Brandeis. The Engineering Magazine, New York. Cloth; 92 pages, 6½x9¼ inches; indexed. Price, $1.

CHEMISTRY FOR BEGINNERS. By Edward Hart. The Chemical Publishing Company, Easton, Penn. Cloth; 214 pages, 5x6½ inches; 78 illustrations; indexed. Price, $1.

PRACTICAL MATHEMATICS AND GEOMETRY FOR TECHNICAL STUDENTS. By Edward L. Bates. D. Van Nostrand Company, New York. Cloth; 446 pages, 4½x7¼ inches; 267 illustrations; tables; indexed. Price, $1.25.

Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power

The other day the Chief Engineer of an electric light and power plant in Iowa wrote to the editor of POWER for some information on recording instruments.

"Would it pay," he asked, "to install a recording thermometer on the feed-water line, a recording pressure gage, a recording flue-temperature instrument, a CO_2 recorder, recording switchboard instruments, recording pressure gage on an exhaust-steam heating system, etc.? I am in favor of such instruments, but only want such as will warrant the investment and must be able to prove same to my company before they can be had.

"Would like to get opinions as to what instruments we need and don't need, and why."

To which the editor replied: "Whether the purchase and installation of the various recording instruments named in your letter will 'pay' depends entirely upon how much you wish to know about the conditions obtaining in your plant.

"Unless your plant is being operated under exceptionally good conditions, a CO_2 recorder will, if the records are intelligently read and appreciated, save its price in a very few weeks.

"The charts from recording instruments of all kinds make a daily history of the plant and are often used to show whether one set of men is doing as well as, or better, than another, and to excite a spirit of emulation which will put every man on his mettle to do as well as possible.

"In short, if you have any desire to keep your plant at or near the head of the list of up-todate plants, recording instruments are a necessity."

Here is the case of a man who didn't realize the value of reading and acting upon the ads in the paper.

If he had read them he wouldn't have needed to write the letter—he would have learned much more about recording instruments from the ads—and from the advertisers' own printed matter than our editor could tell him in a letter.

And this is a good example of just what we are trying to teach in our own weekly talks on this page.

There are many engineers who want who really need information on some kind of power-plant equipment or other, and it doesn't occur to them that they have a veritable encyclopedia of just that information coming to them every week in the Selling Section of POWER.

For of course the very best information possible on everything for the power plant is printed in the advertising pages.

The manufacturers rely on their ads to explain their products and all their features, advantages, savings, etc., to the readers—who are possible buyers.

What they cannot tell in the ads they put forth in booklets, catalogs and letters, which are sent to any reader on request.

Where else could you hope to get as complete details and information?

The engineer whose letter we have quoted is the right sort—he wants to know about any device that will help him get better results for his employers—he is worth every cent of his salary, for he's not content to stand still.

But—he will find that the grand parade of Progress doesn't stop with the reading pages of POWER. The reviewing stand is located in the advertising section and he—and all of you—want to book a seat in the front row where you can see all that's going on in the fast-moving march of the aforesaid procession.

The advertising pages are the heralds of Progress. Read them and heed them.

A New Market for Boilers

A new use has been found for steam, and a new market has been opened to the manufacturer of boilers. Having experimented for years with methods of sterilizing the tobacco beds, to rid them of the weeds and insects which are such a menace to the young plants, the tobacco growers in the vicinity of Windsor, Conn., have adopted the idea of using steam. It has been found that by going over the beds with live steam they are sterilized better than by any of the older methods.

The tobacco growers in the Connecticut valley are just completing sowing their beds. Many of them, before planting the seeds, sterilized the beds with steam, and from experiments heretofore made it is expected that good results will be obtained.

Years ago tobacco growers experimented in sterilizing the tobacco grounds by drawing "brush" onto them and burning it, but this proved to be detrimental to the growth of the seed. The method adopted this year is much different. A boiler is set at a convenient place alongside the bed and steam is generated and fed by pipes to the beds. A funnel-shaped arrangement is attached to the end of the pipe and the steam is forced into the ground to the depth of 6 inches or more. This process is carried on throughout the bed, and is done with such thoroughness that the heat remains in the ground for over three hours.

One grower said that in sterilizing his beds it was necessary to keep a 10-horsepower boiler going full blast in order to keep up steam enough to do the work. It is an expensive arrangement, but it is believed that it will more than pay for the time and trouble.

BUSINESS ITEMS

The Chicago branch of Chas. A. Schieren Company, belt manufacturer, will move into its new quarters at 128 West Kinzie street, Chicago, Ill., about May 1.

The general offices of the Under-Feed Stoker Company of America were removed on May 1 to the eighteenth floor of the Harris Trust building, located on Monroe street, between Clark and La Salle streets, Chicago, Ill.

The Positive Differential System Company has signed a contract with Jenkins Brothers to act as their exclusive selling agent for all the valves and special appliances which are used in its system, both for vacuum return and gravity return line work.

The E. G. Todt Company, machinist and engineer, 9388 Ewing avenue, South Chicago, has been appointed western agent for the Harmon feed-water purifier, a device which is installed in the steam space of the boiler. This purifier is manufactured by F. M. Harmon, 1304 Rockefeller building, Cleveland, Ohio.

D. J. Lewis, Jr., announces his retirement as manager of the Bundy department of the American Radiator Company; his temporary address will be 88 Riggs place, South Orange, N. J. Pending developments, Mr. Lewis will devote his time to any one who may require his services as a consulting mechanical engineer.

The Westinghouse Machine Company, of Pittsburg, Penn., has recently received an order from the Weymouth Light and Power Company for a 625-kilowatt, single-flow, high-pressure turbine to be installed in the power house at East Weymouth, Mass. The turbine will use steam at 150 pounds pressure, and will exhaust into a vacuum of 27 inches, maintained by a Leblanc jet type condenser. Approximately $50,000 will be expended on improvements about the plant, which will make it one of the most uptodate generating stations in Massachusetts.

NEW EQUIPMENT

Wellesley, Mass., will install a new sewer system.

Thessalon, Ont., will install a new electric-lighting plant.

T. H. Stevens, Alice, Tex., will construct a 10-ton ice plant.

Ravelstoke, B. C., will spend $50,000 on a new power plant.

Holyoke, Mass., will spend $15,000 improving its water system.

The Esmond Mills, Esmond, R. I., will install a steam turbine.

Melville, Sask., will spend $60,000 for new waterworks machinery.

Power plant will be required for the new city hall, Cleveland, Ohio.

Camrose, Alberta, will spend $80,000 for new waterworks equipment.

Morgan City, La., will construct waterworks to cost about $60,000.

Logan, Ohio, is preparing plans for the construction of waterworks.

The Columbus (Ohio) Bolt Works is in the market for pressure blowers.

Arcadia, Fla., will vote on the issuance of $20,000 bonds for waterworks.

Leopold D. Caminetti, Jackson, Cal., is preparing to erect a power plant.

A. Bellstein, Toppenish, Wash., will build a new ice and cold-storage plant.

The Union Ice Company, Colusa, Cal., will build a large cold-storage house.

A new power plant will be built at the Portsmouth, N. H., navy yard.

The Peabody (Mass.) Electric Light Works is expecting to install new boilers.

The Union Ice and Cold Storage Company will build an addition to its plant.

Manchester, Tenn., voted $25,000 bonds for electric-light plant and waterworks.

G. C. Bacheller & Co., Bridgeport, Conn., are planning to erect a new power plant.

The Brooks Candy Company, Grand Rapids, Mich., will build a new power plant.

South Jacksonville, Fla., has voted $60,000 bonds for water, light and sewage system.

The American Writing Paper Company will install a new power plant at Holyoke, Mass.

The Yale & Towne Company, Stamford, Conn., will make additions to its power plant.

The town of Franklin, Mass., will spend $50,000 for improvements to its water system.

The Cleveland (Ohio) Electric Illuminating Company is now erecting its $2,500,000 new plant.

The Pacific Gas and Electric Company, Oakland, Cal., will build an addition to its plant.

The Merchants Light and Power Company, Ogden, Utah, is planning to build a power plant.

Wymore, Neb., is asking bids for the construction of a combination power plant and city hall.

The Pattern Manufacturing Company, Chattanooga, Tenn., is in the market for an air compressor.

The Schade Brewing Company, Spokane, Wash., is planning to erect a $20,000 cold-storage plant.

The Andrews Light and Power Company, Salmon City, Idaho, will install new generating equipment.

The Valley Development Company, Portland, Ore., will build a large power plant on the Cowlitz river.

The Cleveland (Ohio) Light and Power Company has increased its capital and will add new equipment.

The Western State Gas and Electric Company, Lodi, Cal., will build a new substation and transformer house.

Cleveland, Ohio, will construct a large market house for which power and refrigeration plant will be required.

Mena, Ark., will spend $60,000 on improvements to waterworks. John Thompson, chairman board of improvements.

The Sacramento (Cal.) Electric Gas and Railway Company is planning to spend $1,500,000 on improvements and additions.

The Class & Macleod Brewing Company, Philadelphia, Penn., will make alterations in its power plant. Oil engines will be installed.

The Jamestown (N. Y.) Street Railway Company is erecting a large addition to its central power station on West Eightieth street.

The Twin City Light and Traction Company, Centralia, Wash., is planning to build a power plant at Chehalis, to cost about $75,000.

Power-plant equipment will be needed for the new building to be erected by R. Huddleston, San Francisco, Cal. Wm. Curlett & Son, architects.

Power-plant equipment will be required for the new hospital building to be erected by the Woman's Hospital Association, Los Angeles, Cal.

The New York & Long Island Traction Company, Hempstead, N. Y., is in the market for a 750-kilowatt rotary converter and three transformers.

The substation of the Newburgh (N. Y.) and the Poughkeepsie Light, Heat and Power Companies, at Highland, N. Y., was burned. Loss, $10,000.

The Northwest Electric Power Company, Portland, Ore., is planning to build a power plant on the White Salmon river, near Husum, Wash.

The National Electric Lamp Company, Cleveland, Ohio, will erect a power plant to furnish light and power for the new buildings to be constructed.

The Siskiyou Electric Light and Power Company, Yreka, Cal., will build a new power plant on the Klamath river to generate about 20,000 horsepower.

The Pierce county commissioners, Tacoma, Wash., are planning to install a power plant for lighting the county buildings. Torger Peterson, chairman.

The Providence (R. I.) Dyeing, Bleaching and Calendering Company expect to erect an addition and will install another engine of about 200 horsepower.

The committee of supervisors, San Francisco, Cal., is arranging for site for a new power house to be erected in connection with the Geary Street municipal railway.

Biloxi, Miss., contemplates installing two new pumps in the waterworks plant, one of

1500 gallons capacity for fire pressure and the other of 5000 gallons capacity. E. I. Castanera, superintendent waterworks.

The Citizens Light and Power Company, Sacramento, Cal., recently incorporated with $2,500,000 capital, is planning to operate extensively in the light, power and gas business. G. W. Peltier, of Sacramento, is at the head of the company.

NEW CATALOGS

The Lagonda Manufacturing Company, Springfield, Ohio. Bulletin R. Lagonda-Enterprise multiple strainers. Illustrated, 8 pages, 6x9 inches.

National Tube Company, Pittsburg, Penn. Pamphlet. The Whole "Kewanee" Family. Unions, couplings, valves, cocks, etc. Illustrated, 32 pages, 5½x8 inches.

The Richardson-Phenix Company, 324 Fourth avenue, Pittsburg, Penn. Bulletin No. 53. Richardson model "M" mechanical lubricator. Illustrated, 16 pages, 6x9 inches.

General Electric Company, Schenectady, N. Y. Bulletin No. 4811. Drum controllers for industrial service. Illustrated. Bulletin No. 4791. Feeder voltage regulators. Illustrated.

Schutte & Koerting Company, Philadelphia, Penn. Catalog Sections. 7-G—Blast governors for Corliss engines. 7-L—Automatic engine lubricator. 8-V—Vacuum breaker valves. 9-E—Grease extractor and feed-water filter. Illustrated.

Westinghouse Electric and Manufacturing Company, Pittsburg, Penn. Circular No. 1165. Fan motors. Illustrated, 48 pages, 7x10 inches. Folder No. 4100. Fan motors for alternating current. Illustrated, 28 pages, 3½x6 inches. Folder No. 4101. Fan motors for direct current. Illustrated, 20 pages, 3½x6 inches.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

WANTED—A salesman having experience in mills supply and plumbing line for central States. Address Box 428, POWER.

WANTED—Experienced foreman engineer for sugar refinery; credentials required. Apply P. O. Box 1660, Vancouver, B. C.

ENGINEERS WANTED to solicit for the Rolin patent adjustable grate. Apply Standard Grate Co., Heed Bldg., Philadelphia.

WANTED—Thoroughly competent steam specialty salesman: one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn Street, Chicago.

AGENTS WANTED for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

SALESMAN calling at power plants to handle as a side line superior packing for steam, different from the rest and better. Nugget Packing Co., 185 Summer St., Boston, Mass.

WANTED—On 500-horsepower plant, 40 miles from New York City; assistant engineer experienced in running gas engines on producer gas; state experience and salary expected. Address Box 427, POWER.

WANTED—An engineer in each city as agent for a high class water-back Scotch boiler, the most economical steam generator known to the trade. Kingsford Foundry & Machine Works, Oswego, N. Y.

ENGINEERING SALESMEN wanted for our Chicago and Cincinnati offices. Apply respectively, Schutte & Koerting Company, 805 Security Building, Chicago, and 12th and Thompson Sts., Philadelphia.

WANTED—High class engineer with first class license to take charge of a strictly up-todate 300 Kva. plant in the city of Detroit; state salary, references, experience and where license is held. Box 425, POWER.

WANTED—A second engineer capable of handling steam and gas power in electric light and power plant of 400 horsepower capacity; state age, qualifications, salary expected and send references; applications to be in by May 15, 1911. E. Roberts, Secretary-Treasurer, Wetaskiwin, Alberta.

WANTED—A first class representative in Pittsburg to handle a reliable high speed engine account on commission basis; prefer a representative who is at present, and will continue, handling power plant equipment that does not compete with the high speed type engine. Box 421, POWER.

WANTED—Engineer to take charge of 50 kilowatt producer gas plant for electric lighting; applicant must be familiar with Westinghouse gas engines and producers; state age, experience and salary desired; climate very good; living expenses about six dollars a week. Address Arsuaga & Co., Ltd., Box 41, Manati, Porto Rico.

SITUATIONS WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

SUPERINTENDENT, gas engine, electric light plant, experienced in complete installations, five years installing, three years operating, open for engagement. Address Box 82, Danbury, Ia.

WANTED—Position as chief engineer or superintendent; 15 years' experience, electric light, ice and power plants; age 35 years; married; strictly temperate; give conditions of plant; prefer location in middle or western States; references; now open for engagement. Box 431, POWER.

A SALES MANAGER and engineer wishes to change; 14 years with present steam specialties; organized and directed selling department in the United States, Canada, West Indies and Europe; has shop, erection and operating experience; economic engineering his specialty; can refer to present employers. Box 429, POWER.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

PATENTS. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 904 G St., Washington, D. C. Write for Inventor's Handbook.

PATENTS—H. W. T. Jenner, patent attorney and mechanical expert, 608 F St., Washington, D. C. I make investigations and report if patent can be had and exact cost.

SUBSCRIBE NOW for the 1911 issue of the Stationary Engineers' Directory of the city of Philadelphia; $5 per copy. Mail checks to Stationary Engineers' Club, 1108 Arch street, Philadelphia, Penn.

ENGINEERS AND FIREMEN—Send 10 cents in stamps for a 40-page pamphlet containing a list of questions asked by an examining board of engineers. Stromberg Publishing Co., 2703 Cass Avenue, St. Louis, Mo.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. T. L. Reeder, 1417 W. Jackson Blvd., Chicago, Ill.

WE WANT the agency of American manufacturers of goods that are required by machinists and engineers; we are importers of American engineering specialties and manufacturers' sole agents for Austria, Hungary and Balkan states, and have ample show rooms and offices. John Kollin & Co., General Office, Budapest, Hungary.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

AIR COMPRESSOR, 6x6, belt driven, horizontal, brand new, perfect condition, $135. Box 432, POWER.

FOR SALE—60 horsepower center crank Erie engine, in fine condition; will sell cheap. Box 430, POWER.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

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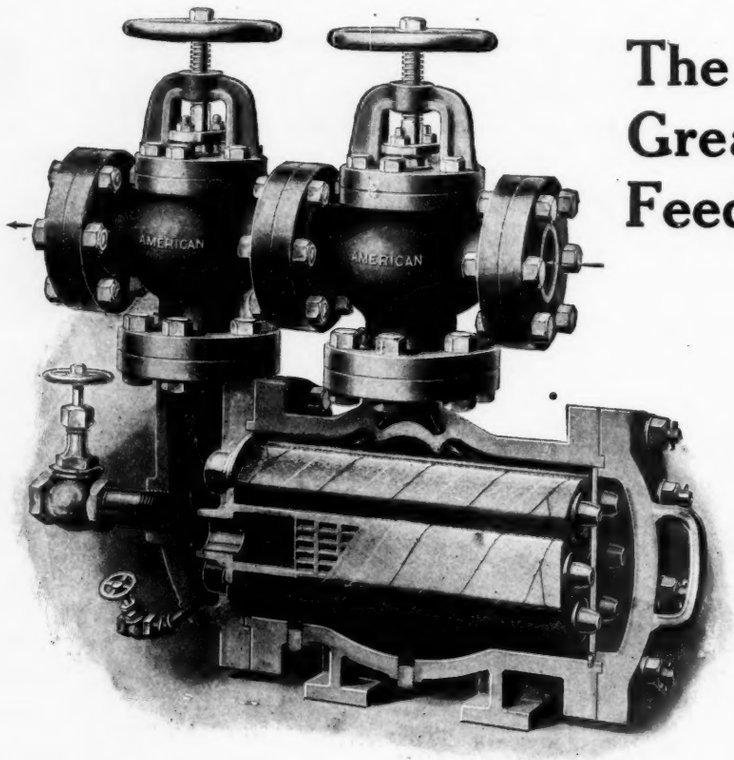

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